BOONTON

BOONTON ELECTRONICS CORPORATION

INSTRUCTION MANUAL
MODEL 5110
LCR METER

MP MASTER

MA31700

INSTRUCTION MANUAL
MODEL 5110
LCR METER

BOONTON
ELECTRONICS CORPORATION

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SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation and maintenance of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Boonton Electronics assumes no liability for the customer's failure to comply with these requirements.

THE INSTRUMENT MUST BE GROUNDED

To minimize shock hazard the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three conductor, three prong a.c. power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to a two-contact adapter with the (green) grounding wire firmly connected to an electrical ground at the power outlet.

DO NOT OPERATE THE INSTRUMENT IN AN EXPLOSIVE ATMOSPHERE.

Do not operate the instrument in the presence of flammable gases or fumes.

KEEP AWAY FROM LIVE CIRCUITS.

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by quailfied maintenance personnel. Do not replace components with the power cable connected. Under certain conditions dangerous voltages may exist even though the power cable was removed, therefore; always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE.

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.

Do not install substitute parts or perform any unauthorized modification of the insturment. Return the instrument to Boonton Electronics for repair to ensure that the safety features are maintained.

SAFETY SYMBOLS.

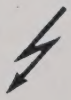
This safety requirement symbol (located on the rear panel) has been adopted by the International Electrotechnical Commission, Document 66 (Central Office) 3, Paragraph 5.3, which directs that and instrument be so labeled if, for the correct use of the instrument, it is necessary to refer to the instruction manual. In this case it is recommended that reference be made to the instruction manual when connecting the instrument to the proper power source. Verify that the correct fuse is installed for the power available, and that the switch on the rear panel is set to the applicable operating voltage.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operation procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the equipment. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

WARNING

The WARNING sign denotes a hazard. It calls attention to an operation procedure, practice, or the like, which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.



Indicates dangerous voltages.

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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This instruction manual provides general information, installation and operating instructions, theory of operation, maintenance instructions, parts list, and schematics for the Model 5110 LCR Meter.

1-3. DESCRIPTION.

1-4. The Boonton Model 5110 LCR Meter is a general purpose inductance, capacitance, and resistance meter that is capable of measuring a wide range of values either locally or over the standard GPIB.

1-5. The instrument has two 3 1/2 digit LED displays. The first display indicates L, C, and R. The second display indicates the dissipation factor (D) concurrent with the capacitance indication, or the quality factor (Q) or (D) concurrent with the inductance measurement.

1-6. The Model 5110 is designed to perform measurements on components upon incoming inspection, production testing and research and development applications. The instrument has three modes of operations which are as follows:

a. Manual operation, utilizing keyboard controls.

b. Automatic operation, after L, C, or R and the test frequency is selected. The instrument selects the correct measuring range and equivalent circuit mode (series or parallel) and then displays the results of the test.

c. Fully compatible IEEE-488 programmable operation under external control with listen and talk modes.

1-7. The Model 5110 design features are as follows:

a. Measurement accuracy for L, C and R is basically ±0.3% of rdg.

b. Three test frequencies, 100 Hz, 120 Hz and 1 kHz are available for measurements from 0.1 pF to 19.99 mF, 0.1 µH to 1.999 kH, and 1 mΩ to 19.99 MΩ. Test frequency accuracy is ±0.3%.

The 100 Hz and 120 Hz test frequencies allow testing of line frequency components used in power supplies.

c. Automatic range and mode selection for samples whose value is unknown, but within the optimum range.

d. The measured values C and D, L and D or Q can be displayed simultaneously. In the L measurement mode, the display can be switched from Q to D.

e. Stray capacitance offset-adjustment can be performed.

f. The measurement level, which is nominally 1 V, may be reduced to 50 mV on the low capacitance ranges where semiconductor measurements are made. DC bias may also be applied to the test via rear panel terminals.

g. Full IEEE-488 GPIB is implemented as the standard on the Model 5110. All front and rear panel controls may be programmed over the bus with the exception of power ON/OFF. Trigger and SRQ are included. Address and terminators are switch selected. The output string consists of status for each parameter followed by data in exponential form.

h. Two 4 wire test adapters are available; one for local connection of radial and coaxial leaded components, and the other for remote connection with Kelvin clips.

1-8. ACCESSORIES.

1-9. The following options are available for the instrument:

a. 5110-1 Test adapter for radial/coaxial lead components.

b. 5110-4 Kelvin clip test adapter with 1 m leads and guard for remote connection of components.

1-10. SPECIFICATIONS.

1-11. Performance specifications are listed in Table 1-1.

TABLE 1-1. Performance Specifications

Parameter	Specification
Measured parameters	Capacitance and D, Resistance, Inductance and D or Q
Test frequencies	100 Hz, 120 Hz, and 1 kHz ± 3%
Ranges:	
Capacitance	1 pF ~ 19.99 mF (8 ranges) at 100 Hz, 120 Hz 0.1 pF ~ 1999 µF (8 ranges) at 1 kHz
Inductance	1 µH ~ 1999 H (7 ranges) at 100 Hz, 120 Hz 0.1 µH ~ 199.9 H (7 ranges) at 1 kHz
Dissipation factor	D to 1.999 in one range Q to 199.9 in one range
Resistance	1 mΩ ~ 19.99 MΩ (8 ranges)
Test modes	Parallel, Series, and Auto or Manual
Test signal level	1 V or less than 50 mV
Test time	500 ms at range hold 500 ms per range change
Displays	LED type, 2 displays, 3½ digit LED annunciators for units, functions, circuit mode, frequency trigger, bias, test level range selection and GPIB
Test inputs	5 terminal configuration
Zero	Capacitance zero control with ± 5 pF range. No zero required for other parameters.
DC bias	External input at rear terminals max. 30 V DC
Dimensions	400 mm (W) x 100 mm (H) x 310 mm (D)
Weight	7.5 kg
Rear Panel	Rear panel slide switches control L D/Q, test level CP 1 V/50 mV, line frequency 50/60 Hz, trig/cont remote/local, ext. DC bias on/off
Accessories	
Test fixtures	
5110-1	Test adapter for radial/coaxial lead components
5110-4	Kelvin clip adapter with 1 m leads and guard for remote connection of components.
GPIB	IEEE-488 interface bus is standard. Implements SH1, AH1, T6, L4, SR1, RL1, DC1 and DT1.

TABLE 1-1. Performance Specifications (CONT.)

L-D/Q Measurement

Measuring Range		1	2	3	4	5	6	7
Measuring Frequency	100/120 Hz	1.999 mH	19.99 mH	199.9 mH	1.999 H	19.99 H	199.9 H	1.999 kH
	1 kHz	199.9 µH	1.999 mH	19.99 mH	199.9 mH	1.999 H	19.99 H	199.9 H
Measuring Signal		——	——	——	1 V			
		50 mA	10 mA	1 mA	100 µA	10 µA	——	
	AUTO	Same as				Same as		
Accuracy of L		——	——	——	±(0.3% + 2 count) × (1 + D)		±(0.8% + 2 count) × (1 + D)	
		±(0.8% + 2 count) × (1 + D)	±(0.3% + 2 count) × (1 + D)				——	
	AUTO	Same as				Same as		
Accuracy of D/Q		——	——	——	$\pm\left(0.5\% + (5 + \frac{Lx}{400})\ \text{count}\right)$		$\pm\left(1\% + (5 + \frac{Lx}{400})\ \text{count}\right)$	
		$\pm\left(0.5\% + (5 + \frac{1000}{Lx})\ \text{count}\right)$					——	
	AUTO	Same as				Same as		

C-D Measurement

Measuring Range		1	2	3	4	5	6	7	8
Measuring Frequency	100/120 Hz	1.999 nF	19.99 nF	199.9 nF	1.999 µF	19.99 µF	199.9 µF	1.999 mF	19.99 mF
	1 kHz	199.9 pF	1.999 nF	19.99 nF	199.9 nF	1.999 µF	19.99 µF	199.9 µF	1.999 mF
Measuring Signal		1 V or 50 mV (1 kHz only)					——		
		——			10 µA	100 µA	1 mA	10 mA	50 mA
	AUTO	Same as				Same as			
Accuracy of C		±(0.3% + 1 count) × (1 + D/2)					♦ at 1 V		
		±(0.8% + 2 count) × (1 + D/2)	±(0.4% + 2 count) × (1 + D/2)				♦ at 50 mV (1 kHz only)		
		——			±(0.3% + 2 count) × (1 + D/2)			±(0.5% + 3 count) × (1 + D)	±(0.8% + 3 count) × (1 + D)
	AUTO	Same as				Same as			
Accuracy of D		$\pm\left(0.3\% + (2 + \frac{1000}{Cx})\ \text{count}\right)$					♦ at 1 V		
		±(1% + (10 + 2000/Cx) count)	$\pm\left(1\% + (5 + \frac{1000}{Cx})\ \text{count}\right)$				♦ at 50 mV (1 kHz only)		
		——			$\pm\left(0.5\% + (3 + \frac{Cx}{400})\ \text{count}\right)$				±(1% + (5 + Cx/400) count)
	AUTO	Same as				Same as			

R Measurement

Measuring Range		1	2	3	4	5	6	7	8
		1.999 Ω	19.99 Ω	199.9 Ω	1.999 kΩ	19.99 kΩ	199.9 kΩ	1.999 MΩ	19.99 MΩ
Measuring Signal		——	——	——	——	1 V			
		50 mA	10 mA	1 mA	100 µA	10 µA	——		
	AUTO	Same as					Same as		
Accuracy of R		——	——	——	±(0.3% + 2 count)				±(0.5% + 2 count)
		±(0.2% + 2 count)					——		
	AUTO	Same as				Same as			

Notes:

- The measuring signal level represents a typical value and varies with the value D, the number of counts, etc.
- % is in reference to an indicated value.
- Lx represents the number of counts of L.
- Cx represents the number of counts of C.
- Q = 1/D
- Accuracy is at 23°C ± 5°C.

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains the installation instructions for the Model 5110 LCR Meter and includes the unpacking, mounting, power requirements, cable connections, and preliminary checkout procedure.

2-3. INSTALLATION.

2-4. Unpacking. The instrument is shipped complete and is ready for use upon receipt. Unpack the instrument from it shipping container and inspect it for damage that may have occurred during shipment.

NOTE

Save the packing material and container for possible use for reshipment of the instrument.

2-5. Mounting. For bench mounting, choose a clean, sturdy, uncluttered mounting surface.

2-6. Power Requirements. The instrument has a tapped power transformer and a line voltage selector plug which permits operation from 100, 120, 220, and 240 volt ±10%. A frequency switch permits operation from either a 50 or 60 Hz, single phase AC power source. Power consumption is approximately 20 watts.

CAUTION

The line voltage selector plug must be set to the correct position most nearly corresponding to the voltage of the available AC power source and a fuse of correct rating must be installed in the fuse holder before connecting the instrument to any AC power source.

2-7. Set the rear panel line voltage selector plug to the appropriate position as indicated on the LINE VOLTAGE SELECT chart. Check that the line fuse, F1 is correct for the selected power source.

Nominal line Voltage	F1
100/120 V	1.0
220/240 V	0.5

2-8. Set the rear panel LINE FREQ switch to the power frequency to be used, either 50 Hz or 60 Hz.

2-9. Measuring Adapters and Test Leads.

a. 2 Terminal measuring method. This method is used when testing a specimen whose impedance is approximately 100 Ω ~ 10 kΩ. Refer to Figure 2-1.

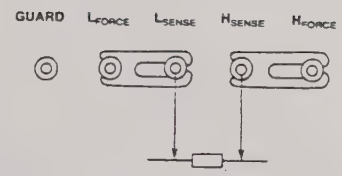


Figure 2-1. 2 Terminal Measuring Method

b. 3 Terminal measuring method. This method eliminates the effect of stray capacitance produced across test lead wires or a nearby conductor and is used to measure small capacitance values, high inductance values, and high resistance values. Refer to Figure 2-2.

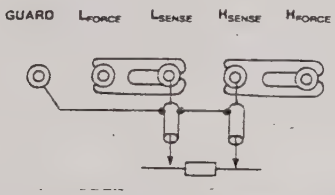


Figure 2-2. 3 Terminal Measuring Method

c. 4 Terminal measuring method. This method eliminates the resistance or residual inductance of lead wires under test or contact resistance with the specimen and is used to measure large capacitances values, low inductance values, and low resistance values. If the connecting cables are long, connect them in the following manner to eliminate measurement errors. Refer to Figure 2-3.

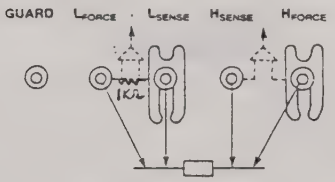


Figure 2-3. 4 Terminal Measuring Method

There is no resistance between H_{SENSE} and H_{FORCE} when the specimen is not connected; therefore, a stable reading may not be obtained. To obtain a stable reading, twist the 2 SENSE cables together and twist the 2 FORCE cables together then connect the test leads as shown. Refer to Figure 2-4.

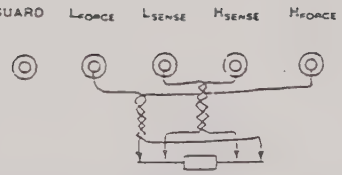


Figure 2-4. 4 Terminal Measuring Method (twisted leads)

d. 5 Terminal measuring method. This method eliminates the stray capacitance produced between test lead wires or with nearby conductors. This method also eliminates the resistance or residual inductance of test lead wires and can be used for all ranges. Refer to Figure 2-5.

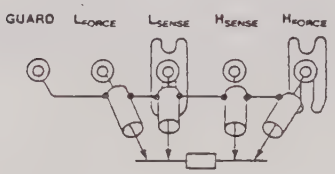


Figure 2-5. 5 Terminal Measuring Method

2-10. Optional test adapters.

a. 5110-1 Test Adapter. The adapter plugs into the instrument and is used to measure double or single lead configuration for small-sized 2 terminal tubular devices and is very convenient to use because it can be connected or disconnected in a short time. The adapter can be used for all ranges; but, should not be used for measuring micro capacitance or extremely small impedances. Refer to Figure 2-6.

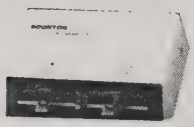


Figure 2-6. 5110-1 Test Adapter

b. 5110-4 Kelvin Clip Adapter. The adapter plugs into the instrument and is used to measure low resistance or low impedance and easily connects to short lead wires. Refer to Figure 2-7.

Figure 2-7. 5110-4 Kelvin Clip Adapter

2-11. Cable Connection. The only cable connection is the IEEE-488 bus connector which provides a means for connecting the standard IEEE-488 bus interface cable and is not supplied with the instrument.

2-12. PRELIMINARY CHECKOUT.

2-13. The preliminary checkout verifies that the instrument is operational and should be performed before the instrument is placed into use. Perform the preliminary checkout as follows:

a. Connect the power cord to the instrument and the desired power source. (Refer to paragraph 2-6 for proper power application.)

b. Set the TRIG/CONT switch to LOCAL.

c. Set the DC BIAS switch to OFF.

d. Set the LEVEL (Cp) switch to 1V.

e. Set the L switch to Q.

f. Securely tighten the short circuit straps found between the SENSE and FORCE terminals for the H to L sides open circuit.

g. Set the POWER ON/OFF switch to ON.

h. Both numerical displays should indicate 1888 and all the lamps should be illuminated.

i. After step h. has been performed. The instrument should automatically set the following conditions:

FUNCTION to C.

RANGE to AUTO.

CIRCUIT MODE to AUTO and PRL.

FREQUENCY to 1 kHz.

j. Decide whether the specimen is to be directly connected to the measuring terminals or the measuring adapter is to be used. If the measurement is to be performed by the 4 or 5 terminal method, tighten the short circuit straps on both H and L sides of the measuring terminals in such a way that one terminal will not touch the other. Then, connect the lead wire or adapter.

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. Section III contains the operating controls, indicators, and connectors description and functions, initial conditions, and operating instructions for the Model 5110.

3-3. OPERATING CONTROLS, INDICATORS, AND CONNECTORS.

3-4. The controls, indicators, and connectors used during operation of the instrument are listed in Table 3-1 and shown in Figures 3-1 and 3-2.

3-5. OPERATING INSTRUCTIONS.

3-6. The operating instructions for the Model 5110 are as follows:

a. Initial conditions.

b. Local operation.

c. IEEE-488 bus operation.

3-7. INITIAL CONDITIONS.

3-8. Set the initial conditions as follows:

a. Connect the power cord to the instrument and the desired power source. (Refer to paragraphs 2-6 and 2-7 for proper power application and fuse selection.)

b. Set the rear panel LINE FREQ switch to the frequency of the power to be used.

c. Set the TRIG/CONT switch to LOCAL.

d. Set the DC BIAS switch to OFF.

e. Set the LEVEL (CP) switch to 1V.

f. Set the L switch to Q.

g. Connect the short circuit straps between the ^{L}FORCE/^{L}SENSE and ^{H}FORCE/^{H}SENSE measuring terminals.

h. Set the POWER ON/OFF switch to ON.

i. Both displays should indicate 1888.

j. Verify that all the lamps illuminate.

k. The instrument will automatically be set to:

FUNCTION	C
RANGE	AUTO
CIRCUIT MODE	AUTO PRL
FREQUENCY	1 kHz

3-9. LOCAL OPERATION.

3-10. Capacitance Measurements. Capacitance measurements can be performed either automatically or manually.

WARNING

Do not, under any circumstance, attempt to connect or measure any specimen to which voltage is applied. Discharge all capacitors before connection, to prevent personal injury and damage to the instrument.

3-11. Automatic Capacitance Measurements. Perform the automatic capacitance measurement as follows:

a. Depress the C FUNCTION key. The C LED will illuminate and the instrument is ready to measure capacitance.

b. Decide whether the specimen is to be directly connected to the measuring terminals or if an adapter is to be used. If the measurement is to be performed using the 4 or 5 terminal method, tighten the short circuit straps on both H and L sides of the measuring terminals in such a way that one terminal will not touch the other, then connect the lead wire or adapter.

c. Depress the RANGE AUTO key to place the instrument in the automatic range mode.

d. Depress the CIRCUIT MODE AUTO key to place the instrument in the automatic circuit mode.

e. Set the FREQUENCY switch to 100 Hz, 120 Hz, or 1 kHz, depending on what test frequency is desired.

NOTE

Set the FREQUENCY switch to 120 Hz when measuring electrolytic capacitors and 1 kHz when testing other devices.

f. With the measuring fixture connected and before connecting the specimen to the measuring terminals, set the C ZERO control located on the front panel so that the indicated C value reads 00.0 pF. This adjustment compensates for the stray capacitance of the measuring fixture lead wire, etc.

g. After the specimen is connected the instrument will automatically select the optimum measuring range, circuit mode, and will display the capacitance value, dissipation factor (D), units, and measuring circuit mode.

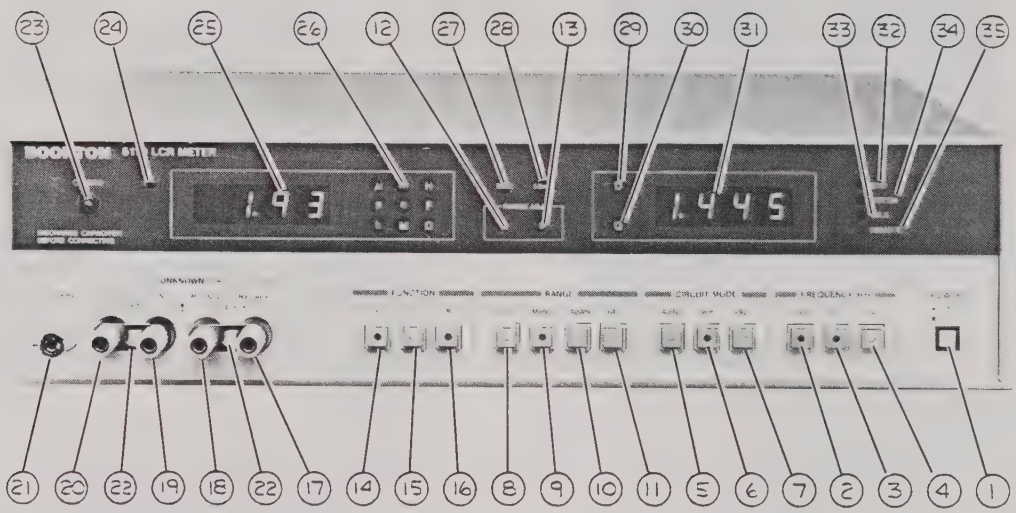


Figure 3-1. Model 5110, Front View

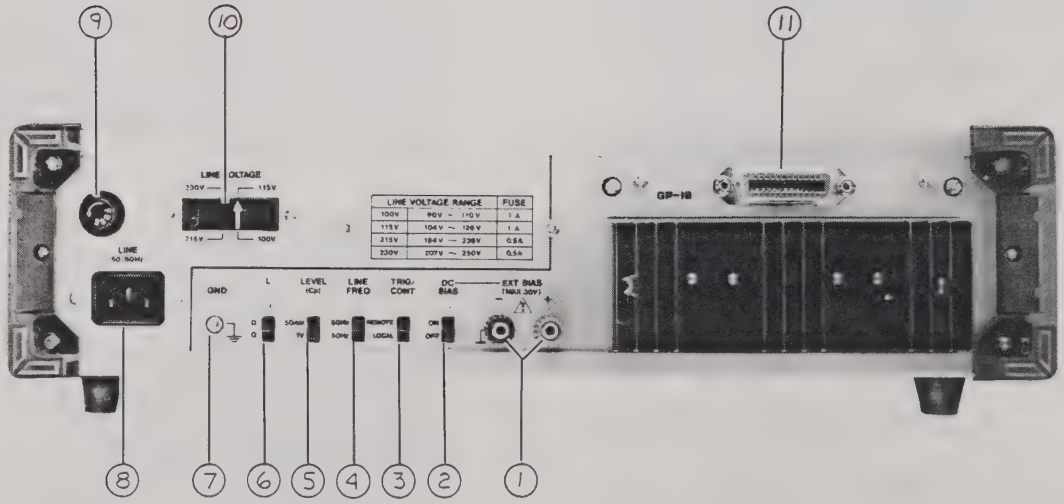


Figure 3-2. Model 5110, Rear View

TABLE 3-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS

Control, Indicator, or Connector.	Figure 3-1 Index No.	Function.
POWER switch	1	Switches the AC power ON and OFF.
FREQUENCY switches (measuring frequency)		Used to set the measuring frequency.
100 Hz	2	Selects 100 Hz measuring frequency.
120 Hz	3	Selects 120 Hz measuring frequency.
1 kHz	4	Selects 1 kHz measuring frequency.
CIRCUIT MODE switches (measuring circuit mode)		Used to select the measuring circuit mode at which the specimen is to be measured. Series equivalent circuit or parallel equivalent circuit.
AUTO switch	5	Selects the optimum mode, either SER or PRL.
SER switch	6	Selects series mode. The SER LED will flicker when the mode is not in conformity with the range.
PRL switch	7	Selects parallel mode. The PRL LED will flicker when the mode is not in conformity with the range.
RANGE switches		Selects the range at which the specimen is measured.
AUTO switch	8	Selects the automatic range selection mode whereby the optimum range is automatically selected. AUTO range switching action can be accomplished in the following manner: 2000 counts or more (up to 1999 in display) for range-up and 180 counts or less for range-down.
MANU switch	9	Selects the manual range selection mode whereby the measurement range is manually selected.
DOWN switch	10	Selects a lower measurement range.
UP switch	11	Selects a higher measurement range.
RANGE ADJ LEDs		Flickering LED indicates that the measurement range selected is too high or too low.
< Left hand LED	12	Flickering LED indicates that the measurement range selected is too high. Depress the DOWN switch.
> Right hand LED	13	Flickering LED indicates that the measurement range selected is too low. Depress the UP switch.

TABLE 3-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (CONT.)

Control, Indicator, or Connector.	Figure 3-1 Index No.	Function.
FUNCTION Keys		Used to select either the L, C, or R function.
L Key	14	Selects the inductance function.
C Key	15	Selects the capacitance function.
R Key	16	Selects the resistance function.
MEASURING Terminals		Terminals used for connecting the specimen, (4).
H_{FORCE}	17	Connects the specimen to the signal impression HIGH side.
H_{SENSE}	18	Connects the specimen to the signal detection HIGH side.
L_{SENSE}	19	Connects the specimen to the signal detection LOW side.
L_{FORCE}	20	Connects the specimen to the signal impression LOW side.
GUARD Terminal	21	Provides a signal ground and is used to improve measuring accuracy, especially when testing a specimen of high impedance.
Short Circuit Straps	22	Used to establish a short between respective terminals on the HIGH side and LOW side.
C ZERO	23	Adjustment used to compensate for the stray capacitance in the lead wire, fixture, and across the measuring terminals when the specimen is not connected.
TRIGGER LED	24	When the LED is not flickering no measurement is being performed. Flickering LED indicates that a repeated measurement is being performed. When starting a measurement using an external trigger, the LED will flicker once for each measurement cycle.
L,C, or R Display	25	Used to display the measured values of inductance, capacitance, or resistance. Measured values will be displayed in decimal notation of $3\frac{1}{2}$ digits with numerals 000 ~ 1999 and a decimal point.

TABLE 3-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (CONT.)

Control, Indicator, or Connector.	Figure 3-1 Index No.	Function.
FUNCTION LEDs	26	Indicates what parameter is being measured and what the multiplier is.
Ω		Indicates ohms.
F		Indicates Farads.
H		Indicates henrys.
P		Indicates pico.
n		Indicates nano.
μ		Indicates micro.
m		Indicates milli.
k		Indicates kilo.
M		Indicates mega.
BIAS LED	27	Indicates that the DC BIAS switch is set to ON and external bias will be applied.
50 mV LED	28	Indicates that the LEVEL (CP) switch located on the rear panel is set to 50 mV. The LED will go out if any mode other than the parallel capacity mode is selected.
D LED	29	Indicates that a dissipation factor is being measured and displayed.
Q LED	30	Indicates that a quality factor is being measured and displayed.
D or Q Display	31	Used to display the dissipation factor, D, or quality factor, Q. Measured values will be displayed in decimal notation of $3\frac{1}{2}$ digits with numerals 000 ~ 1999 and a decimal point.
GPIB LEDs		
SRQ	32	Indicates service request enabled.
TALK	33	Indicates talker is addressed.
LISTEN	34	Indicates listener is addressed.
REMOTE	35	Indicates the IEEE-488 bus is active.

TABLE 3-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (CONT.)

Control, Indicator, or Connector.	Figure 3-2 Index No.	Function.
EXT BIAS (MAX. 30V) terminals	1	Terminals used for inputting an external bias.
DC BIAS switch	2	Used to apply a DC bias to electrolytic capacitors.
TRIG/CONT switch	3	Selects either a triggered measurement for remote operation or continuous measurements for local operation.
LINE FREQ switch	4	Selects either 50 Hz or 60 Hz line frequency operation.
LEVEL (CP) switch	5	Selects either a 1 V or 50 mV level measuring signal to be applied to the specimen to be measured.
L switch	6	Selects either Q or D. When Q is selected while measuring inductance the Q factor will be displayed. When D is selected the D factor will be displayed.
GND terminal	7	Used as a ground connection for the LCR meter.
Power cord connector	8	Used to plug in the power cord.
Power fuse	9	Used to protect the instrument
LINE VOLTAGE switch	10	Used to select the proper operating line voltage.
GPIB connector	11	Provides a means for connecting the standard IEEE-488 bus interface cable.

3-11. (CONT.)

NOTE

If a specimen dissipation factor D reading exceeds 1.999, the value showing the dissipation factor will disappear.

3-12. Manual Capacitance Measurements. Perform the manual capacitance measurement as follows:

a. Depress the C FUNCTION key. The C LED will illuminate and the instrument is ready to measure capacitance.

b. Connect the specimen to the measuring terminals or adapter as applicable.

c. Depress the MANU key to place the instrument in the manual range mode.

d. Depress the CIRCUIT MODE AUTO key to place the instrument in the automatic circuit mode.

e. Set the FREQUENCY switch to 100 Hz, 120 Hz, or 1 kHz, depending on what test frequency is desired.

3-12. (CONT.)

f. Set the front panel C ZERO control so that the displayed C value reads 00.0 PF.

g. After the specimen is connected, observe the UP key LED and the DOWN key LED.

h. If neither the UP key LED nor the DOWN key LED is flickering, the instrument will display the capacitance value, dissipation factor (D), unit, and measuring circuit mode of the specimen.

NOTE

To accomplish one up range switching, depress the UP key once; when lowering the range, depress the DOWN key once. The optimum range will be selected at a state in which neither lamp flickers. When testing specimens of similar types continuously, depress the MANU key and fix the range to save measuring time. If the measured value exceeds the scale, 1.999, the display will disappear.

i. If the UP key LED is flickering depress the UP key to increase the range until the LED stops flickering, the instrument will display the capacitance value, dissipation factor (D), unit, and measuring circuit mode of the specimen.

j. If the DOWN key LED is flickering depress the DOWN key to decrease the range until the LED stops flickering, the instrument will display the capacitance value, dissipation factor (D), unit, and measuring circuit mode of the specimen.

3-13. Circuit Mode Manual SER or PRL dissipation (D) factor measurements.

NOTE

The instrument must be set for manual operation and the measuring range must be as specified in the Specification Table C-D Measurements.

a. Depress the SER or PRL key to select a series or parallel dissipation factors (D) measurement.

b. The LED of the mode selected will illuminate, the AUTO LED will go out, and the instrument will display the capacitance value, dissipation factor (D), unit, and measuring circuit mode of the specimen, if the instrument is set to the proper range.

c. If the measurement cannot be made the SER or PRL LED will flicker, depress the MODE key that is not flickering. If the instrument is set to the proper range, the instrument will display the capacitance value, dissipation factor (D), unit, and measuring circuit mode of the specimen.

d. If a measurement cannot be made and both MODE keys flicker when selected, the instrument is not set to the proper range; therefore, refer to the Specifications, Table C-D Measurements. Set the proper range and perform the measurement over.

3-14. Capacitance (Electrolytic) Measurements Utilizing External DC Bias. Perform the measurement as follows:

CAUTION

When applying a DC bias to a capacitor, use the external bias terminals and do not apply a voltage greater than 30 VDC. Connect the capacitor observing the proper polarity.

a. Connect the specimen to perform a 4-terminal measurement. To eliminate the effects of the measuring lead wires, use the shortest possible lead wires to connect the specimen to the instrument.

b. Set the DC BIAS switch to OFF.

c. Connect external power to the EXT BIAS (MAX 30V) terminals located on the rear panel.

d. Set the DC BIAS switch to ON.

e. Refer to paragraph 3-11 or 3-12 and perform the capacitance measurement.

3-15. Inductance Measurements. Inductance measurements can be performed either automatically or manually.

3-16. Automatic Inductance Measurements. Perform the automatic inductance measurements as follows:

a. Depress the L FUNCTION key. The L LED will illuminate and the instrument is ready to measure inductance.

b. Connect the specimen to the measuring terminals or adapter as applicable.

c. Depress the RANGE AUTO key to place the instrument in the automatic range mode.

d. Depress the CIRCUIT MODE AUTO key to place the instrument in the automatic circuit mode.

e. Set the FREQUENCY switch to 100 Hz, 120 Hz, or 1 kHz, depending on what test frequency is desired.

f. Set the L switch to Q for quality or D for dissipation of the specimen.

g. After the specimen is connected, the instrument will automatically select the optimum measuring range, circuit mode, and will display the inductance value, the Q or D value, unit, and measuring circuit mode.

NOTE

If D exceeds 1.999 or Q exceeds 199.9, the display will not indicate.

3-17. Manual Inductance Measurements. Perform the manual inductance measurements as follows:

a. Depress the L FUNCTION key. The L LED will illuminate and the instrument is ready to measure inductance.

b. Connect the specimen to the measuring terminals or adapter as applicable.

c. Depress the MANU key to place the instrument in the manual range mode.

d. Depress the CIRCUIT MODE AUTO key to place the instrument in the automatic circuit mode.

e. After the specimen is connected, observe the UP key LED and the DOWN key LED.

f. If neither the UP key LED nor the DOWN key LED is flickering, the instrument will display the inductance value, dissipation factor (D) or quality (Q), unit, and measuring circuit mode of the specimen.

g. If the UP key LED is flickering depress the UP key to increase the range until the LED stops flickering, the instrument will display the inductance value, dissipation factor (D) or quality (Q), unit, and measuring circuit mode of the specimen.

h. If the DOWN key LED is flickering depress the DOWN key to decrease the range until the LED stops flickering, the instrument will display the inductance value, dissipation factor (D) or quality (Q), unit, and measuring circuit mode of the specimen.

3-18. Circuit Mode Manual SER or PRL dissipation (D) or quality (Q) factor measurements.

a. Depress the SER or PRL key to select a series or parallel dissipation factors (D) or quality (Q) measurement.

b. The LED of the mode selected will illuminate, the AUTO LED will go out, and the instrument will display the inductance value, dissipation factor (D) or quality (Q), unit, and measuring circuit mode of the specimen, if the instrument is set to the proper range.

c. If the measurement cannot be made the SER or PRL LED will flicker, depress the MODE key that is not flickering. If the instrument is set to the proper range, the instrument will display the inductance value, dissipation factor (D) or quality (Q), unit and measuring circuit mode of the specimen.

d. If a measurement cannot be made and both MODE keys flicker when selected, the instrument is not set to the proper range, therefore, refer to the Specifications, Table C-D Measurements. Set the proper range and perform the measurement over.

3-19. Resistance Measurements. Resistance measurements can be performed either automatically or manually.

3-20. Automatic resistance measurements. Perform the automatic resistance measurements as follows:

a. Depress the R FUNCTION key. The R LED will illuminate and the instrument is ready to measure resistance.

b. Connect the specimen to the measuring terminals or adapter as applicable.

c. Depress the RANGE AUTO key to place the instrument in the automatic range mode.

d. Depress the CIRCUIT MODE AUTO key to place the instrument in the automatic circuit mode.

e. Set the FREQUENCY switch to 1 kHz.

f. After the specimen is connected, the instrument will automatically select the optimum measuring range, circuit mode, and will display the resistance value.

3-21. Manual Resistance Measurements. Perform the manual resistance measurement as follows:

a. Depress the R FUNCTION key. The R LED will illuminate and the instrument is ready to measure resistance.

b. Connect the specimen to the measuring terminals or adapter as applicable.

c. Depress the MANU key to place the instrument in the manual range mode.

d. Depress the CIRCUIT MODE AUTO key to place the instrument in the automatic circuit mode.

e. After the specimen is connected, observe the UP key LED and the DOWN key LED.

f. If neither the UP key LED nor the DOWN key LED is flickering, the instrument will display the resistance value.

g. If the UP key LED is flickering depress the UP key to increase the range until the LED stops flickering, the instrument will display the resistance value.

3-21. (CONT.)

h. If the DOWN key LED is flickering depress the DOWN key to decrease the range until the LED stops flickering, the instrument will display the resistance value.

3-22. Resistance/Inductance measurements. When the resistance of wire wound resistors is measured the inductance of the resistor must be considered, therefore; to properly measure the resistance perform the following procedure.

a. Perform the Automatic or Manual resistance measurement procedure and set the CIRCUIT MODE switch to SER.

3-23. Resistance/Capacitance measurements. When a high resistance is measured the presence of parallel capacitance must be considered, therefore; to properly measure the resistance perform the following procedure.

a. Perform the Automatic or Manual resistance measurement procedure and set the CIRCUIT MODE switch to PRL.

3-24. Series Equivalent Resistance (R_S) of a cored coil or transformer measurements. When the (R_S) of a cored coil or transformer is measured perform the following procedure.

a. Perform the Manual Inductance measurement procedure and set the CIRCUIT MODE to SER.

b. Depress the R FUNCTION key. The instrument will display the (R_S) of the cored coil or transformer.

3-25. IEEE-488 Bus Operation.

3-26. Interface Function. Refer to Table 3-2 for the GPIB Interface Functions.

3-27. IEEE-488 LED Indicators. The following four LED lamps are provided on the front panel to indicate the status of GPIB interface.

SRQ: Indicates that the SRQ (service request) signal is sent from the device to the GPIB bus line.

LISTEN: Indicates that the device is set to Listener.

TALK: Indicates that the device is set to Talker.

REMOTE: Indicates that the device is remote-controlled. The remote mode takes place when MLA is received with the GPIB bus line in the remote (REN.LLO) mode.

3-28. GPIB switch (address delimiter). The device employs a primary address method and is set to Delimiter (00) and Address (00101) at the time of shipment.

The Address Delimiter switch located on the GPIB interface board provides the means for setting the address and delimiter functions. Refer to Figures 3-3, 3-4 and Table 3-3.

3-29. Input-Output Format and Output Status Byte. The input format sent by the controller and the status byte and output format sent by the instrument are shown in Table 3-4.

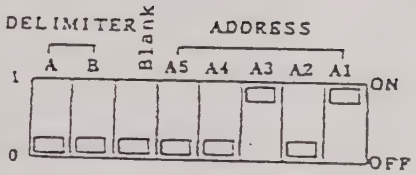


Figure 3-3. GPIB Switch (Address Delimiter)

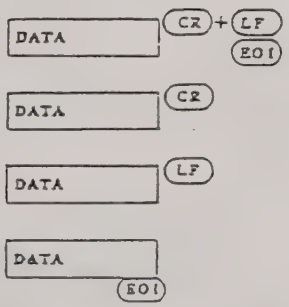


Figure 3-4. Address Delimiter Contents Chart

TABLE 3-2. Interface Functions

Name	Code	Function
Source Handshake	SH 1	Source handshake function
Acceptor Handshake	AH 1	Acceptor handshake function
Talker	T 6	Basic talker Serial poll Talker cancellation by MLA
Listener	L 4	Basic listener Listener cancellation by MTA
Service Request	SR 1	Sending of message in serial pole mode
Remote/Local	RL 1	Remote/Local changeover function (without local switch)
Device Clear	DC 1	Function for initializing the device
Device Trigger	DT 1	Function for trigger-controlling the device

(Note) No talk-only function is provided.

TABLE 3-3. Address Delimiter Functions

DELIMITER A	DELIMITER B	CONTENTS	OUTPUT CODE
0	0	CR+LF (EOI is output to LF)	CR+LF
0	1	CR Only	CR
1	0	LF Only	LF
1	1	EOI output to final byte of data	-

ADDRESS A5	A4	A3	A2	A1	10 decimal	NOTE
0	0	0	0	0	0 0	Arbitrary setting
				∫	∫	
1	1	1	1	0	3 0	
1	1	1	1	1	3 1	Prohibited to use

3-30. Input format. Measuring conditions are set by sending the following program codes.

```
(Example of input format)
PRINT @5; "F1 R0 M0 A2 B0 S1 E1"
    F1:  FUNCTION C
    R0:  AUTO RANGE
    M0:  AUTO MODE
    A2:  FREQUENCY 1kHz
    B0:  BIAS OFF
    S1:  SRQ ON
    E1:  GET START
```

3-31. Output status byte of service request. The service request function can be used by setting the program code to "S1" after turning the power ON. The device status byte is arranged as shown in Table 3-5.

3-32. Output format. The numerical data is output in an exponential form (fixed-point part + exponent part). The output format for Inductance and Capacitance measurements and Resistance measurements is shown in Table 3-6. Refer to Table 3-7 for a complete output format statement.

3-33. IEEE-488 Measurement Precautions.

a. Program precautions.

1. All switches found on the front panel and rear panel can be software-controlled by program codes.

2. The controller assigns the device to Listener and sends the program code of necessary setting conditions.

3. By setting "E1" in the program code, measurements can be started with a GET message.

4. The controller assigns the device to Talker and reads the data.

5. When making service request (SRQ) in serial poll, be sure to read the status byte corresponding to that request on the controller side.

TABLE 3-4. Input-Output Format

Functions	Program codes	Contents	Remarks
Measuring function	F 0	Inductance measurement	L-D, L-Q
	F 1	Capacitance measurement	C-D
	F 2	Resistance measurement	R
Measuring range	R 0	Auto range setting	
	R 1	Range 1	
	R 2	Range 2	
	R 3	Range 3	
	R 4	Range 4	
	R 5	Range 5	
	R 6	Range 6	
	R 7	Range 7	
	R 8	Range 8	There is no Range 8 for L measurement.
Measuring mode	M 0	Auto mode setting	AUTO
	M 1	Series mode setting	SER
	M 2	Parallel mode setting	PAR
Measuring frequency	A 0	100 Hz	
	A 1	120 Hz	
	A 2	1 kHz	50 Hz area
	A 3	1.02 kHz	60 Hz area
External bias ON/OFF	B 0	Bias OFF	
	B 1	Bias ON	
Measuring signal voltage	L 0	50 mV rms	The measuring signal 50 mV can be set only at the time of parallel capacitance measurement. (at A2 A3)
	L 1	1.0 V rms	
Display of dissipation in Inductance measurement	Q 0	Display D	Display "D" (dissipation) in Inductance measurement
	Q 1	Display Q	Display "Q" (quality of coil) in Inductance measurement

TABLE 3-4. Input-Output Format (CONT.)			
Service request SRQ	S 0 S 1	Service request OFF Service request ON	
Measurement starting (trigger)	E 0 E 1	Internal trigger External trigger	Address command GET START

TABLE 3-5. Output Status Bytes

Bit	7	6	5	4	3	2	1	0
	0	RQS	0	0	0	COMMAND ERROR	PROGRAM ERROR	DATA READY
(DIO	8)	(7)	(6)	(5)	(4)	(3)	(2)	(1)

Set to 1 when service request occurs with the program code at S1, then the SRQ line is set to True.

Set to 1 when handshake error, unrecognized command, etc. occur.

Set to 1 when erroneous remote program code or numerical data is received.

Set to 1 when preparation of data to be sent is complete.

TABLE 3-6. L, C, and R Measurement Output Format

Inductance and Capacitance measurement:

4 letters	5 letters	4 letters	1 letter	2 letters	5 letters	
NCPC	DATA 1	E ± X X	,	ND	DATA 2	CRLF (EOI)
Data item	Fixed-point part	Exponent part	Marking off	Data item	Fixed-point part	Delimiter

Resistance measurement:

4 letters	5 letters	4 letters	
NRSC	DATA 1	E ± X X	CRLF (EOI)
Data item	Fixed-point part	Exponent part	Delimiter

TABLE 3-7. Output Format Statement

Example output format statement:

```
N C P C 1.999  E-06  , N D 1.999  CRLF
↑↑ ↑ ↑  ↑      ↑      ↑ ↑ ↑  ↑      ↑
1 2 3 4  5     6      7 8 9  10     11
```

No.	Output code	Contents
1 8	N O	Measurement data normal Over-range
2	L C R	Inductance measurement Capacitance measurement Resistance measurement
3	S P	Series mode measurement Parallel mode measurement
4	A B C D	100 Hz 120 Hz 1 kHz 1.02 kHz
5 10	5 10	LCR data D, Q data
6	E - 12 E - 09 E - 06 E - 03 E + 00 E + 03 E + 06	PF nF µH µF mH mF H kH Ω kΩ MΩ
7	,	Marking-off of data
9	D Q	Dissipation factor Quality of coil
11	Delimiter	Refer to delimiter output format

3-34. Example Programs.

The following are examples of IEEE-488 controller programs:

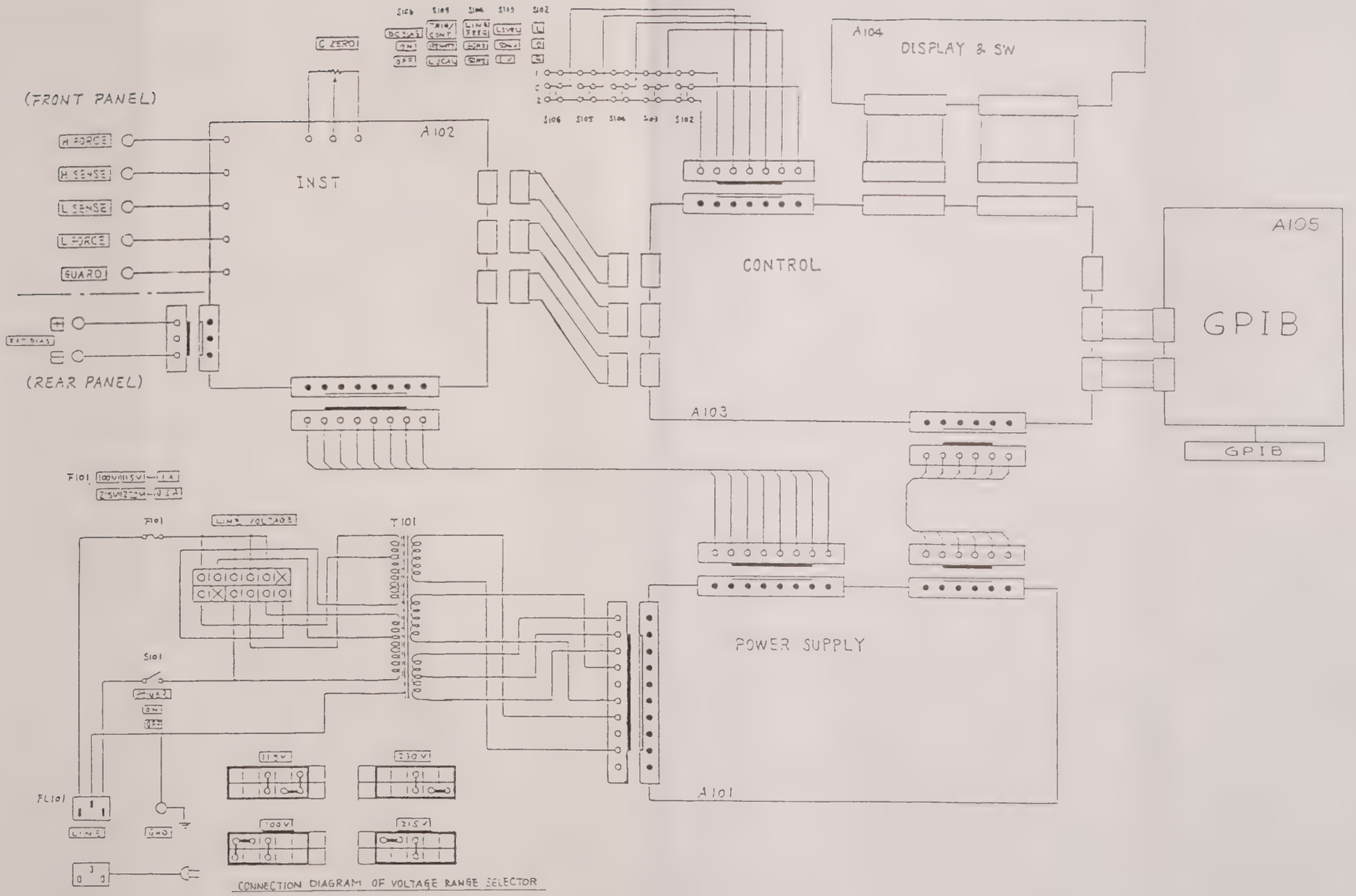
```
10   REM*****GP-IB TEST PROGRAM (1)*****
20   REM*****NEC-PC8001 N BASIC    *****
30   DEF USR0=&H6000
40   A=USR0(1)
50   ISET IFC                          'INTERFACE CLEAR
60   ISET REN                          'REMOTE ENABLE
70   CMD DELIM=0                       'DELIMITER ASSIGNMENT
80   CMD TIMEOUT=2                     'TIME-OUT PARAMETER
90   '
100  ON SRQ GOSUB 200                 'SRQ SUBROUTINE
110  FOR I=0 TO 500:NEXT I             'SETUP DELAY
120  PRINT @5;"F1R0M0A2B0L1Q1S1E1"     'DATA IS SENT AS ASC II CHARACTERS
130  A$="START"
140  WBYTE &H25,&H8;                   'GET START
150  IF A$<>"END" THEN 150
160  GOTO 130
170  '
200  POLL 5,B                          'SERIAL POLL
210  IF IEEE(4) <> &H41 THEN 300       'DEVICE STATUS
220  INPUT @5;C$,D$                    'DATA RECEPTION
230  PRINT C$,D$
240  A$="END"
250  SRQ ENABLE                        'SRQ RECEPTION IS PERMITTED
260  RETURN
270  '
300  PRINT "ERROR"                     'PROCESSING OF ERROR
310  END


10   ! ******** HP1B TEST PROGRAM(2) ********
20   !       HP-9000 SERIES 200 COMPUTERS
30   !            MODEL 216
40   ! ************************************
50   !
60   ABORT 7                           ! INTERFACE CLEAR
70   REMOTE 7                          ! REMOTE ENABLE
80   OUTPUT 705;"F1R0M0A2B0L1Q1S0E1"   ! UNL+MLA+DATA
90   TRIGGER 705                       ! GROUP EXCUTE TRIGGER
100  ENTER 705;A$,B$                   ! UNT+MTA+STRING$
110  PRINT A$'B$                       ! DISP DATA LCR;DQ
120  GOTO 90
130  END
```

SECTION IV

THEORY OF OPERATIONS

4-1. INTRODUCTION.

4-2. This section contains the Functional Block Diagram Figure 4-1, the Control Secton Block Diagram Figure 4-2, and the Analog Section Block Diagram Figure 4-3.



SCHEMATIC, OVERALL
831460A SH 10

Figure 4-1.
Functional Block Diagram
4-3/4-4

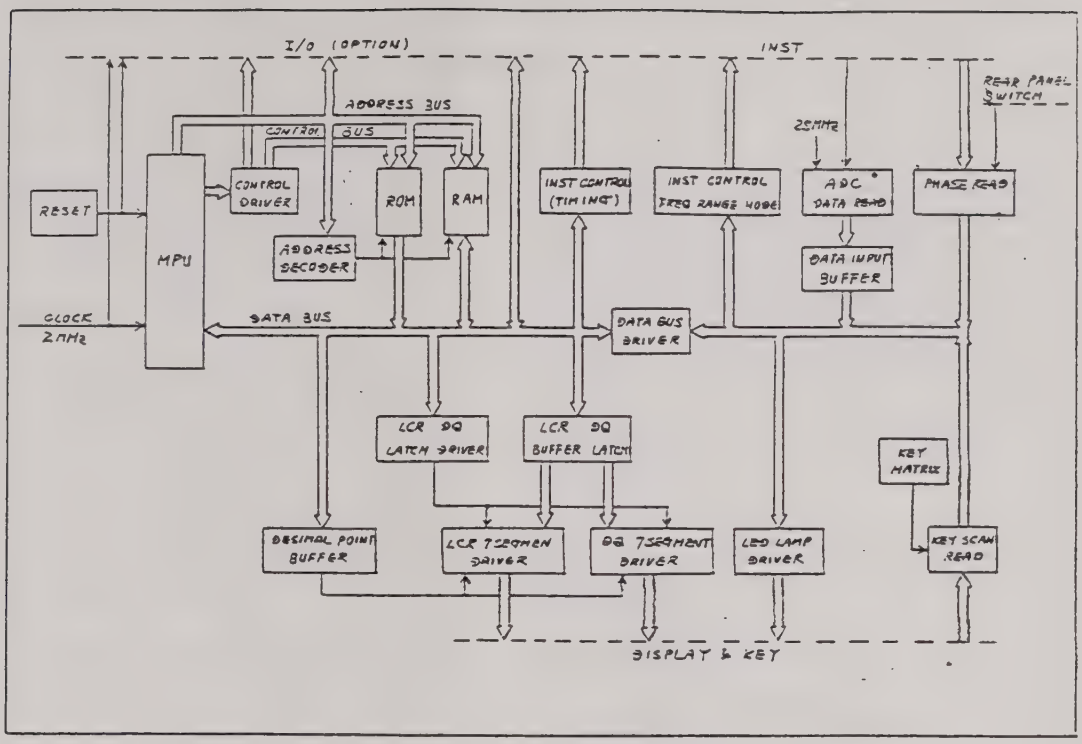


Figure 4-2. Control Section Block Diagram.

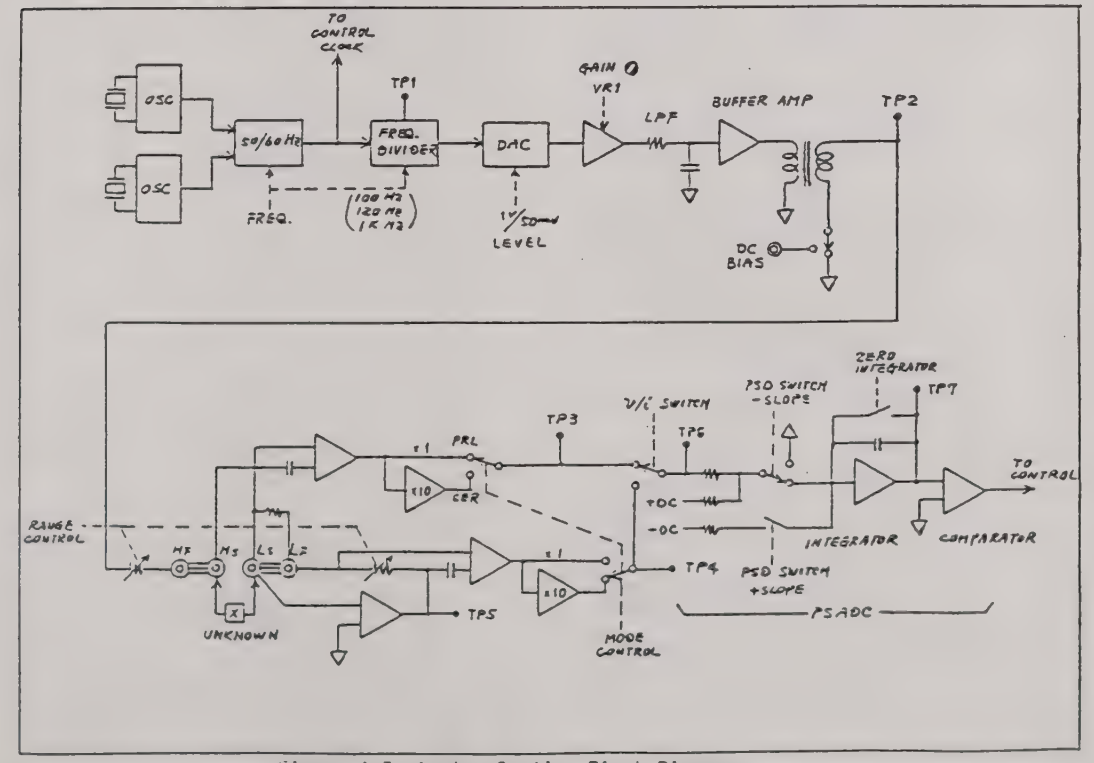


Figure 4-3. Analog Section Block Diagram.

SECTION V

MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains the safety requirements, test equipment required, inspection procedure, performance test, and adjustment procedure for the Model 5110. Refer to Figure 5-1 for the Model 5110 Adjustment Location Diagram.

5-3. SAFETY REQUIREMENTS.

5-4. Although this instrument has been designed in accordance with international safety standards, general safety precautions must be observed during all phases of operation and maintenance of the instrument. Failure to comply with the precautions listed in the Safety Summary located in the front of this manual could result in serious injury or death. Service and adjustment should be performed only by qualified service personnel.

5-5. TEST EQUIPMENT REQUIRED.

5-6. Test equipment required for the performance tests and adjustment procedure is listed in Table 5-1.

TABLE 5-1.
MAINTENANCE TEST EQUIPMENT REQUIRED

Frequency Counter	Phillips PM-6614 (or equivalent)
AC Voltmeter	HP 339 (or equivalent)
Capacitance Standards 1 µF, 0.1 µF, 0.01 µF.	GR Type 1409 (or equivalent)
Inductance Standards 100 µH, 1 mH, 10 mH, 100 mH, 1 H, 10 H.	GR Type 1482-B (or equivalent)
Resistance Box	ESI DB877 (or equivalent)
DC Voltmeter	Keithley 177 (or equivalent)
Power Supply	Lambda LPO 421 FM (or equivalent)
Controller	HP 85B (or equivalent)

5-7. INSPECTION.

5-8. If an equipment malfunction occurs, perform a visual inspection of the Model 5110. Inspect for signs of damage caused by excessive shock, vibration, or overheating, such as broken wires, loose hardware and parts, loose electrical connections, electrical shorts, cold solder connections, or accumulations of dirt and other foreign matter. Correct any problems discovered, then perform the performance tests to verify that the instrument is operational. If a malfunction persists or the instrument fails any of the performance tests, troubleshoot the instrument utilizing standard troubleshooting methods.

5-9. PERFORMANCE TESTS.

5-10. Initial conditions. Set the inital conditions as specified in Section III, paragraph 3-7.

5-11. Measuring Frequency Test. Perform the tests as follows:

a. Connect a frequency counter to the measuring terminals as follows:

High side to ^{H}FORCE/^{H}SENSE

Low or ground side to ^{L}FORCE/^{L}SENSE

b. Depress the FREQUENCY MHz 100 key, observe the frequency counter and verify that the frequency is 100 Hz ±3%.

c. Depress the FREQUENCY MHz 120 key, observe the frequency counter and verify that the frequency is 120 Hz ±3%.

d. Depress the FREQUENCY MHz 1k key, observe the frequency counter and verify that the frequency is 1000 Hz ±3%.

5-12. Measuring Level Test. Perform the tests as follows:

a. Connect an AC voltmeter (HP 339) to the measuring terminals as follows:

High side to ^{H}FORCE/^{H}SENSE

Low or ground side to ^{L}FORCE/^{L}SENSE.

b. Set front panel controls as follows:

FUNCTION: C
RANGE: MANU .000 µF
CIRCUIT MODE: PRL
FREQUENCY (Hz): 1k

c. Observe the AC voltmeter and verify that the test level voltage is 1 V RMS ±5%.

5-12. (CONT.)

d. Set rear panel LEVEL switch to 50 mV. The front panel 50 mV LED should be ON.

e. Observe the AC voltmeter and verify that the test level voltage is 50 mV ±20%.

f. Set the rear panel LEVEL switch to 1 volt.

5-13. C ZERO Test. Perform the test as follows:

a. Set the front panel controls as follows:

FUNCTION:	C
RANGE:	AUTO (Range 00.0 pF)
CIRCUIT MODE:	AUTO
FREQUENCY (Hz):	1k

b. Adjust C ZERO (screwdriver adjustment) control thru its range. Note that there is no polarity sign to indicate minus zero. Capacitance indication at maximum clockwise rotation should not be less than 5.0 pF.

c. Adjust C ZERO control for 00.0 pF.

5-14. Capacitance Standard Test. Perform the tests as follows:

a. Connect the following GR Type 1409 capacitance standards to the measuring terminals, utilizing the two terminal connection method. (Use a 6 inch length of coaxial cable with banana pin adapters for high value capacitance measurements.) Connect the standard high terminal to ^{H}FORCE/^{H}SENSE and the low terminal to ^{L}FORCE/^{L}SENSE.

b. Connect the 1409Y 1 µF Standard to the measuring terminals and verify that the instrument L, C, and R display indicates 999.0 nF ±4 counts and the D or Q display indicates .000 ±1 count.

c. Connect the following GR Type 1409 capacitance standards to the measuring terminals, utilizing the two terminal connection method. (Use a 6 inch length of coaxial cable with banana pin adapters for high value capacitance measurements.) Connect the standard high terminal to ^{H}FORCE/^{H}SENSE and the low terminal to ^{L}FORCE/^{L}SENSE.

d. Connect the 1409T 0.1 µF Standard to the measuring terminals and verify that the instrument L, C, and R display indicates 99.95 nF ±4 counts and the D or Q display indicates D .000 ±1 count.

e. Connect the 1409L 0.01 µF Standard to the measuring terminals and verify that the instrument L, C, and R display indicates 10.01 nF ±4 counts and the D or Q display indicates D .000 ±1 count.

5-15. Inductance Standard Tests. Perform the tests as follows:

a. Connect the short circuit straps between the ^{L}FORCE/^{L}SENSE and ^{H}FORCE/^{H}SENSE measuring terminals.

b. Set the front panel controls as follows:

FUNCTION:	L
RANGE:	AUTO
CIRCUIT MODE:	AUTO
FREQUENCY (Hz):	1k

c. Connect the following GR Type 1482 inductance standards to the measuring terminals, utilizing a BNC adapter.

d. Connect the 1482-B 100 µH Standard to the BNC adapter and verify that the instrument L, C, and R display indicates 100.1 µH ±0.8% ±2 counts and the Q display indicates 3.6 ±0.5% ±1 count.

e. Set the rear panel LDQ switch to D and verify that the D display indicates .277 ±0.5% ±5 counts.

f. Set the rear panel LDQ switch to Q.

g. Connect the 1482-E 1 mH Standard to the BNC adapter and verify that the instrument L, C, and R display indicates 0.998 mH ±0.3% ±2 counts and the Q display indicates 7.9 ±0.5% ±1 count.

h. Set the rear panel LDQ switch to D and verify that the D display indicates .127 ±0.5% ±5 counts.

i. Set the rear panel LDQ switch to Q.

j. Connect the 1482-H 10 mH Standard to the BNC adapter and verify that the instrument L, C, and R display indicates 10.00 mH ±0.3% ±2 counts and the Q display indicates 7.8 ±0.5% ±1 count.

k. Set the rear panel LDQ switch to D and verify that the D display indicates .128 ±0.5% ±5 counts.

l. Set the rear panel LDQ switch to Q.

m. Connect the 1482-L 100 mH Standard to the BNC adapter and verify that the instrument L, C, and R display indicates 99.9 mH ±0.3% ±2 counts and the Q display indicates 7.1 ±0.5% ±1 count.

n. Set the rear panel LDQ switch to D and verify that the D display indicates .141 ±0.5% ±5 counts.

o. Set the rear panel LDQ switch to Q.

p. Connect the 1482-P 1 H Standard to the BNC adapter and verify that the instrument L, C, and R display indicates 1.002 H ±0.3% ±2 counts and the Q display indicates 10.6 ±0.5% ±1 count.

q. Set the rear panel LDQ switch to D and verify that the D display indicates .094 ±0.5% ±5 counts.

r. Set the rear panel LDQ switch to Q.

s. Connect the 1482-T 10 H Standard to the BNC adapter and verify that the instrument L, C, and R display indicates 10.47 H ±0.8% ±2 counts and the Q display indicates 7.8 ±0.5% ±1 count.

t. Set the rear panel LDQ switch to D and verify that the D display indicates .128 ±0.5% ±5 counts.

u. Set the rear panel LDQ switch to Q.

5-16. Resistance Standard Test. Perform the tests as follows:

a. Set the front panel controls as follows:

FUNCTION:	R
RANGE:	AUTO
CIRCUIT MODE:	AUTO
FREQUENCY (Hz):	1k

b. Connect the short circuit straps between the ^{L}FORCE/^{L}SENSE and ^{H}FORCE/^{H}SENSE measuring terminals.

c. Connect the resistance box, ESI DB877 to the measuring terminals. Use the 2 terminal and guard connection method.

d. Set the resistance box so that the instrument L, C, or R display indicates 19.99 kΩ.

e. Increase the setting of the resistance box in 10 ohm steps and verify that the instrument auto range up function operates at 19.99, and up ranges to indicate 20.0 kΩ.

f. Set the resistance box for 18.0 kΩ and verify that the instrument auto range down function operates at 18.0, and down ranges to indicate 18.00 kΩ.

g. Set the resistance box for 20 kΩ and verify that the instrument L, C, or R display indicates 20.00 kΩ ±0.3% ±2 counts.

h. Set the resistance box for 1 MΩ and verify that the instrument L, C, or R display indicates 1.0 MΩ ±0.3% ±2 counts.

i. Set the resistance box for 1.5 MΩ and verify that the instrument L, C, or R display indicates 1.5 MΩ ±0.3% ±2 counts.

j. Set the resistance box for 10 MΩ and verify that the instrument L, C, or R display indicates 10.0 MΩ ±0.3% ±2 counts.

5-17. EXT DC BIAS test. Perform the test as follows:

a. Connect a DC Voltmeter to the instrument measuring terminals. Positive to ^{H}FORCE/^{H}SENSE and negative to ^{L}FORCE/^{L}SENSE.

b. Connect a +15 volt DC supply to the rear panel EXT BIAS terminals. Positive to red. Negative to black.

c. Set the DC BIAS switch to ON, observe the instrument front panel and verify that the BIAS LED is ON.

d. Observe the DC Voltmeter and verify that the DC bias is +15 VDC.

e. Set the DC BIAS switch to OFF, observe the instrument front panel and verify that the BIAS LED is OFF.

f. Remove the +15 volt DC supply from the rear panel EXT BIAS terminals.

5-18. 5110-1 Test Adapter Test. Perform the test as follows:

a. Remove the short circuit straps from measuring terminals ^{L}FORCE/^{L}SENSE and ^{H}FORCE/^{H}SENSE.

b. Plug the 5110-1 Test Adapter in to the instrument measuring terminals.

c. Set front panel controls as follows:

FUNCTION:	C
RANGE:	AUTO
CIRCUIT MODE:	AUTO
FREQUENCY (Hz):	1k

d. Connect a test capacitor of a known value and dissipation factor to the 5110-1 Test Adapter.

e. Verify that the instrument L, C, or R and D or Q displays indicate the proper value and dissipation factor of the test capacitor.

f. Remove the 5110-1 Test Adapter.

5-19. 5110-4 Test Adapter Test. Perform the test as follows:

a. Plug the 5110-4 Test Adapter in to the instrument measuring terminals.

b. Connect a test capacitor of a known value and dissipation factor to the 5110-4 Test Adapter.

c. Verify that the instrument L, C, or R and D or Q displays indicate the proper value and dissipation factor of the test capacitor.

d. Remove the 5110-4 Test Adapter.

5-20. GPIB Operation Test.

a. Test the GPIB interface operation as follows:

b. Connect the HP 85B controller to instrument rear panel GPIB connector.

c. Run the following program:

```
10   DIM A$[30]
20   CLEAR @ DISP "MODEL 5110 IEEE-488 BUSS
     TEST"
25   DISP "INSTRUMENT SERIAL NO." @ INPUT S$
26   PRINT USING "2X,12A,X,8A,9A,2/";"5110
     SER NO.", S$,"BUS S TEST"
30   DISP "ENTER DEVICE ADDRESS" @ INPUT K
40   OUTPUT K; "F0M2A0B0Q0"
50   ENTER K; A$@ B$=A$[1,4]
60   IF B$#"OLPA" THEN PRINT "INDUCTANCE
     PARALLEL MODE FAILURE" @ GOTO 80
70   PRINT "PASSED INDUCTANCE PARALLEL
     MODE"
80   OUTPUT K; "M1"
90   ENTER K; A$@ B$=A$[1,4]
100  IF B$#"OLSA" THEN PRINT "INDUCTANCE
     SERIES MODE FAILURE" @ GOTO 120
110  PRINT "PASSED INDUCTANCE SERIES MODE"
120  OUTPUT K; "Q0"
130  ENTER K; A$@ B$=A$[16,16]
140  IF B$#"D" THEN PRINT "INDUCTANCE
     DISSIPATION FAILURE" @ GOTO 160
150  PRINT "PASSED INDUCTANCE DISSIPATION"
160  OUTPUT K; "Q1"
170  ENTER K; A$@ B$=A$[16,16]
180  IF B$#"Q" THEN PRINT "INDUCTANCE Q
     FAILURE" @ GOTO 200
190  PRINT "PASSED INDUCTANCE Q"
200  OUTPUT K; "F1Q0R0M2A0"
210  ENTER K; A$@ B$=A$[1,4] @ C$=A$[16,16]
220  IF B$#"OCPA" OR C$#"D" THEN PRINT
     "CAPACITANCE DISSIPATION ON PARALLEL
     MODE FAILURE" @ GOTO 240
230  PRINT "PASSED CAPACITANCE DISSIPATION
     PARALLEL MODE"
240  OUTPUT K; "M1"
250  ENTER K; A$@ B$=A$[1,4]
260  IF B$#"OCSA" THEN PRINT "CAPACITANCE
     DISSIPATION SERIES MODE FAILURE" @
     GOTO 280
270  PRINT "PASSED CAPACITANCE DISSIPATION
     SERIES MODE"
280  OUTPUT K; "F2M2A0"
290  ENTER K; A$@ B$=A$[1,4]
300  IF B$#"ORPA" THEN PRINT "RESISTANCE
     PARALLEL MODE FAILURE" @ GOTO 320
310  PRINT "PASSED RESISTANCE PARALLEL
     MODE"
320  OUTPUT K; "M1"
330  ENTER K; A$@ B$=A$[1,4]
340  IF B$#"ORSA" THEN PRINT "RESISTANCE
     SERIES MODE FAILURE" @ GOTO 360
350  PRINT "PASSED RESISTANCE SERIES MODE"
360  OUTPUT K; "A1M2"
370  ENTER K; A$@ B$=A$[4,4]
380  IF B$#"B" THEN PRINT "120 Hz FAILURE"
     @ GOTO 440
390  PRINT "PASSED 120 Hz"
400  OUTPUT K; "A3"
410  ENTER K; A$@ B$=A$[4,4]
420  IF B$#"D" THEN PRINT "1 kHz FAILURE"
     @ GOTO 440
430  PRINT "PASSED 1 kHz"
440  OUTPUT K; "F1M2B0L1S0"
450  CLEAR @ DISP "CHECK THAT BIAS, 50 mV
     LAMPS ARE OFF"
455  DISP "PRESS <CONT> WHEN READY" @ BEEP
     @ PAUSE
460  OUTPUT K; "B1L0S1"
470  CLEAR @ DISP "CHECK THAT BIAS AND 50
     mV LAMPS ARE ON AND SRQ LAMP IS
     FLASHING"
475  DISP "PRESS <CONT> WHEN READY" @ BEEP
     @ PAUSE
480  RESET 7
490  CLEAR @ DISP "CHECK THAT BUSS HAS
     RESET" @ DISP "PRESS <CONT> WHEN
     READY" @ BEEP @ PAUSE
500  PRINT USING "13A,10/"; "TEST FINISHED"
     @ CLEAR @ DISP "TEST FINISHED"
510  END
```

5-21. ADJUSTMENT.

5-22. Test Level Adjustment. Perform the adjustment as follows:

a. Disconnect all power to the instrument and remove the bottom cover.

b. Place the instrument on its side to allow access to potentiometer VR1. VR1 is located approximately 3 inches behind the front panel ON/OFF switch on the instrument PC board. Refer to Figure 5-1. Adjustment Location Diagram for the location of VR1.

c. Apply power to the instrument and set the power ON/OFF switch to ON.

d. Set the front panel controls as follows:

FUNCTION:	C
RANGE:	MANU (.000 µF)
CIRCUIT MODE:	PRL
FREQUENCY (Hz):	1k

e. Set the rear panel switches to the following positions:

L:	Q
LEVEL (Cp):	1 V
LINE FREQ:	50 Hz
TRIG/CONT:	LOCAL
DC BIAS:	OFF

f. Connect the short circuit straps between the ^{L}FORCE/^{L}SENSE and ^{H}FORCE/^{H}SENSE measuring terminals.

g. Connect an AC voltmeter (HP 339) or equivalent to the measuring terminals as follows:

High side to ^{H}FORCE/^{H}SENSE

Low or ground side to ^{L}FORCE/^{L}SENSE.

h. Observe the voltmeter and adjust VR1 for 1 V ±5%.

i. Disconnect all power to the instrument and replace the bottom cover.

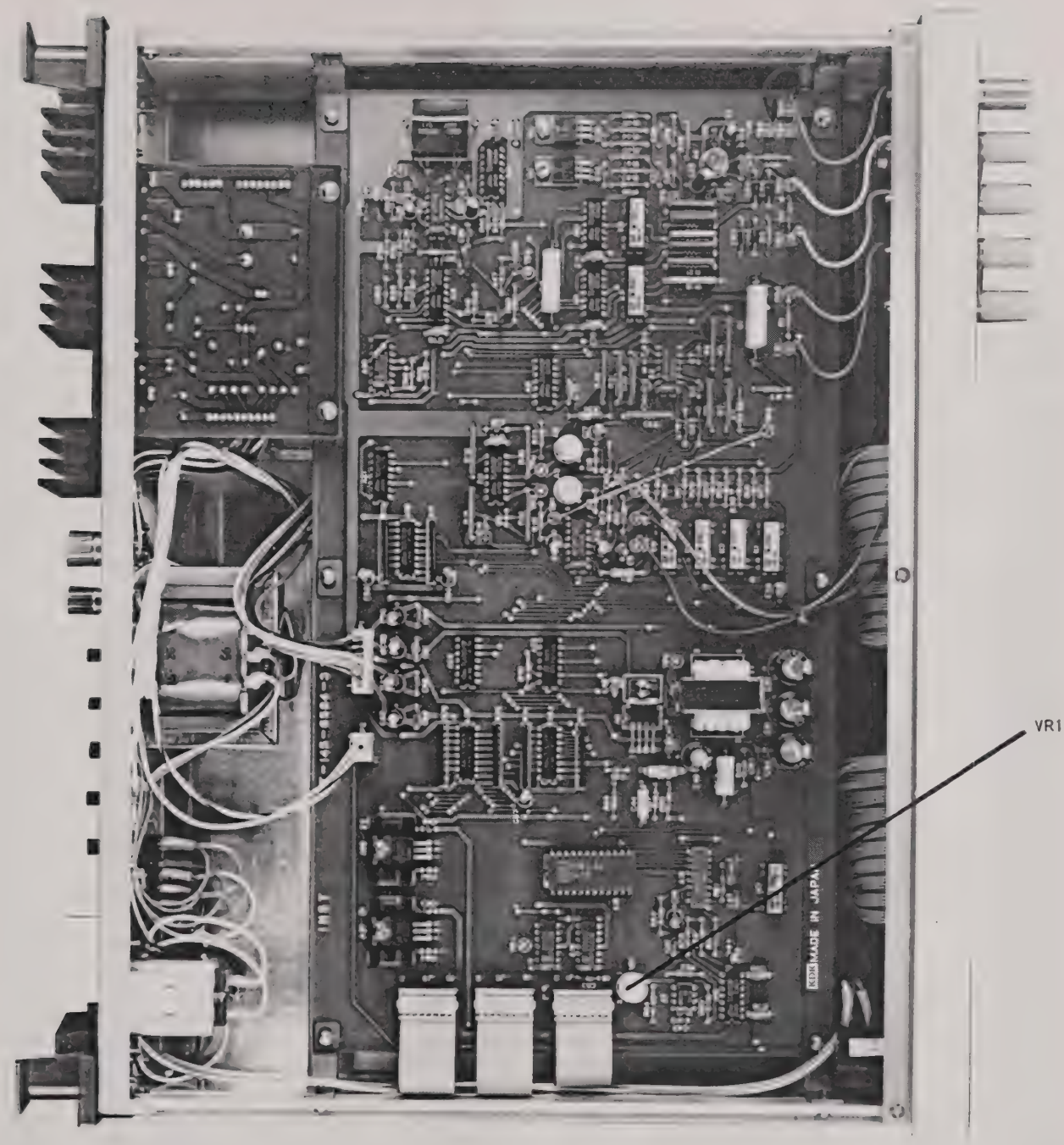


Figure 5-1. Adjustment Location Diagram

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. Table 6-1. Replaceable Parts, lists the replaceable parts and includes; the reference designator, description, and the BEC Part No.

TABLE 6-1. REPLACEABLE PARTS

REFERENCE DESIGNATOR	DESCRIPTION	QTY	BEC PART NUMBER
LC1	LINE CORD	1	568106000
RMK	RACK MTG KIT PARTS	1	051110000
SRW.DR	SCREW DRIVER	1	815026000
F1	FUSE KIT 220V 0.5A	1	96300601A
F101	FUSE 1A	1	51100001
FL101	LINE NOISE FILTER 1A 250V	1	51100003
J101	VOLTAGE SELECTOR	1	51100004
S101	SWITCH PUSH SPST	1	51100006
S102	SWITCH SLIDE DPDT	1	51100007
S103	SWITCH SLIDE DPDT	1	51100007
S104	SWITCH SLIDE DPDT	1	51100007
S105	SWITCH SLIDE DPDT	1	51100007
S106	SWITCH SLIDE DPDT	1	51100007
T101	TRANSFORMER POWER	1	51100005
TB101	TERMINAL RED	1	51100008
TB102	TERMINAL RED	1	51100008
TB103	TERMINAL BLACK	1	51100009
TB104	TERMINAL BLACK	1	51100009
TB105	TERMINAL METAL	1	51100010
TB106	TERMINAL RED	1	51100008
TB107	TERMINAL BLACK	1	51100009
TB108	TERMINAL METAL	1	51100010
VR101	RESISTOR VAR 500 OHM 0.1W	1	51100011
W108	CORD ASSEMBLY	1	51100019
W109	CORD ASSEMBLY	1	51100019
W110	CORD ASSEMBLY	1	51100019
W111	CORD ASSEMBLY	1	51100020
W112	CORD ASSEMBLY	1	51100020
W113	CORD ASSEMBLY	1	51100020
W114	CORD ASSEMBLY	1	51100020
W115	CORD ASSEMBLY	1	51100020
W116	CORD POWER SVT 2.4mm	1	51100021
W117	CORD POWER SVT 2.4mm	1	51100021
W118	CORD POWER SVT 2.4mm	1	51100021
W119	CORD POWER SVT 2.4mm	1	51100022
XF101	FUSEHOLDER 10A 250V	1	51100002

REFERENCE DESIGNATOR	DESCRIPTION	QTY	BEC PART NUMBER
A101	PWA POWER SUPPLY 5110	1	51101000
A1	IC VOLTAGE REGULATOR MC7812CT	1	51101001
A2	IC VOLTAGE REGULATOR MC7912CT	1	51101002
A3	IC VOLTAGE REGULATOR MC7908CT	1	51101003
A4	IC VOLTAGE REGULATOR MC7805CT	1	51101004
A5	IC VOLTAGE REGULATOR MC7805CT	1	51101004
C1	CAPACITOR EL 470uF 20% 35V	1	51101005
C2	CAPACITOR EL 470uF 20% 35V	1	51101005
C5	CAPACITOR TANT 1uF 10% 35V	1	51101006
C6	CAPACITOR TANT 1uF 10% 35V	1	51101006
C7	CAPACITOR EL 330uF 20% 25V	1	51101007
C9	CAPACITOR TANT 1uF 10% 35V	1	51101006
C10	CAPACITOR EL 4700uF 20% 25V	1	51101008
C13	CAPACITOR TANT 1uF 10% 35V	1	51101006
C14	CAPACITOR TANT 1uF 10% 35V	1	51101006
CR1	DIODE 100V 0.6A	1	51101009
CR2	DIODE 100V 0.6A	1	51101009
CR3	DIODE 100V 4.0A	1	51101010
CR4	DIODE 100V 1.0A	1	51101011
CR5	DIODE 100V 1.0A	1	51101011
P1	CONNECTOR 10 PIN	1	51101012
P2	CONNECTOR 8 PIN	1	51101013
P3	CONNECTOR 6 PIN	1	51101014
TB1	PLUG PIN	1	51101015
TB2	PLUG PIN	1	51101015
Z1	HEATSINK 6021P3	1	51101016
A102	PWA INSTRUMENT 5110	1	51102000
A1	IC OPER AMPLIFIER LM348	1	51102001
A2	IC OPER AMPLIFIER LM348	1	51102001
A3	IC OPER AMPLIFIER LF356H	1	51102002
A4	IC OPER AMPLIFIER CA3130	1	51102003
A5	IC OPER AMPLIFIER LF356H	1	51102002
A6	IC OPER AMPLIFIER LM348	1	51102001
A7	IC OPER AMPLIFIER LM301	1	51102004
A8	IC OPER AMPLIFIER UA759UIC	1	51102005

TABLE 6-1. REPLACEABLE PARTS (CONT)

REFERENCE DESIGNATOR	DESCRIPTION	QTY	BEC PART NUMBER
A9	IC SWITCH MC14066BP	1	51102006
A10	IC SWITCH MC14066BP	1	51102006
A11	IC SWITCH MC14066BP	1	51102006
A12	IC SWITCH MC14066BP	1	51102006
A13	IC SWITCH MC14066BP	1	51102006
A14	IC SWITCH MC14066BP	1	51102006
A15	IC SWITCH MC14066BP	1	51102006
A16	IC CMOS MM74C93N	1	51102007
A17	IC CMOS MM74C93N	1	51102007
A18	IC ROM 6341-2	1	51102008
A19	IC D/A DAC-08-CO	1	51102009
A20	IC CMOS MM74C175N	1	51102010
A21	IC CMOS MC14011BP	1	51102011
A22	IC TTL SN7406N	1	51102012
A23	IC CMOS MC14069BP	1	51102013
A24	IC CMOS TC5066BP	1	51102014
A25	IC CMOS TC5066BP	1	51102014
A26	IC CMOS TC5066BP	1	51102014
A27	IC VOLTAGE REGULATOR MC7805CT	1	51101004
A28	IC VOLTAGE REGULATOR MC7908CT	1	51101003
C1	CAPACITOR FILM 0.47uF 10% 200V	1	51102015
C2	CAPACITOR CER 10pF +-0.5pF 50V	1	51102016
C3	CAPACITOR EL 10uF 20% 16V	1	51102017
C4	CAPACITOR EL 10uF 20% 16V	1	51102017
C5	CAPACITOR CER 10pF +-0.5pF 50V	1	51102016
C6	CAPACITOR CER 30pF 5% 50V	1	51102018
C7	CAPACITOR CER 10pF +-0.5pF 50V	1	51102016
C10	CAPACITOR CER 470pF 5% 50V	1	51102019
C11	CAPACITOR CER 100pF 5% 50V	1	51102020
C12	CAPACITOR CER 68pF 5% 50V	1	51102021
C13	CAPACITOR CER 10pF +-0.5pF 50V	1	51102016
C14	CAPACITOR CER 10pF +-0.5pF 50V	1	51102016
C15	CAPACITOR FILM 0.47uF 10% 200V	1	51102015
C17	CAPACITOR EL 10uF 20% 16V	1	51102017
C18	CAPACITOR CEL 100pF 5% 50V	1	51102022
C19	CAPACITOR CEL 10pF +-0.5pF 50V	1	51102023
C20	CAPACITOR CEL 10pF +-0.5pF 50V	1	51102023
C21	CAPACITOR CEL 150pF 5% 50V	1	51102024
C22	CAPACITOR EL 10uF 20% 16V	1	51102017
C23	CAPACITOR EL 10uF 20% 16V	1	51102017
C24	CAPACITOR CEL 100pF 5% 50V	1	51102022
C25	CAPACITOR CEL 100pF 5% 50V	1	51102022
C26	CAPACITOR CEL 0.01uF 20% 50V	1	51102025
C27	CAPACITOR CEL 0.01uF 20% 50V	1	51102025
C28	CAPACITOR CEL 100pF 5% 50V	1	51102022
C29	CAPACITOR CEL 1000pF 10% 50V	1	51102026
C30	CAPACITOR FILM 0.022uF 10% 50V	1	51101027
C31	CAPACITOR FILM 2200pF 10% 50V	1	51102028
C32	CAPACITOR FILM 0.01uF 10% 50V	1	51102029
C33	CAPACITOR CEL 100pF 5% 50V	1	51102022
C34	CAPACITOR CEL 100pF 5% 50V	1	51102022
C35	CAPACITOR FILM 0.1uF 1% 50V	1	51102030
C36	CAPACITOR CEL 100pF 5% 50V	1	51102022
C37	CAPACITOR EL 10uF 20% 16V	1	51102017
C38	CAPACITOR EL 10uF 20% 16V	1	51102017
C39	CAPACITOR EL 10uF 20% 16V	1	51102017
C40	CAPACITOR TANT 10uF10% 25V	1	51102031
C41	CAPACITOR TANT 2.2uF 10% 25V	1	51102032
C42	CAPACITOR CEL 33pF 5% 50V	1	51102033
C43	CAPACITOR CEL 150pF 5% 50V	1	51102024
C44	CAPACITOR FILM 1000pF 5% 150V	1	51102034
C45	CAPACITOR CEL 68pF 5% 50V	1	51102035
C46	CAPACITOR FILM 230pF 5% 150V	1	51102036
C47	CAPACITOR EL 10uF 20% 16V	1	51102017
C48	CAPACITOR EL 10uF 20% 16V	1	51102017
C49	CAPACITOR EL 220uF 20% 16V	1	51102037
C50	CAPACITOR EL 330uF 20% 50V	1	51102038
C51	CAPACITOR EL 330uF 20% 50V	1	51102038
C52	CAPACITOR EL 330uF 20% 50V	1	51102038
C53	CAPACITOR CER 330pF 10% 50V	1	51102039
C54	CAPACITOR EL 10uF 20% 16V	1	51102017
C55	CAPACITOR EL 10uF 20% 16V	1	51102017
C56	CAPACITOR EL 10uF 20% 16V	1	51102017
C57	CAPACITOR EL 10uF 20% 16V	1	51102017
C58	CAPACITOR EL 47uF 20% 16V	1	51102040
C59	CAPACITOR EL 47uF 20% 16V	1	51102040
C60	CAPACITOR CER 0.01uF 20% 50V	1	51102041
C61	CAPACITOR CER 0.01uF 20% 50V	1	51102041
C63	CAPACITOR TANT 1uF 10% 35V	1	51101006
C65	CAPACITOR TANT 1uF 10% 35V	1	51101006
C66	CAPACITOR EL 47uF 20% 16V	1	51102040
C67	CAPACITOR EL 47uF 20% 16V	1	51102040
C68	CAPACITOR CEL 0.01uF 20% 50V	1	51102025
C69	CAPACITOR CEL 0.01uF 20% 50V	1	51102025
C70	CAPACITOR CEL 0.1uF 20% 12V	1	51102042
C71	CAPACITOR CEL 0.1uF 20% 12V	1	51102042
C72	CAPACITOR CEL 0.1uF 20% 12V	1	51102042
C73	CAPACITOR CEL 0.1uF 20% 12V	1	51102042
C74	CAPACITOR CEL 0.1uF 20% 12V	1	51102042
C75	CAPACITOR CEL 0.1uF 20% 12V	1	51102042
C76	CAPACITOR CEL 0.1uF 20% 12V	1	51102042
C77	CAPACITOR FILM 0.1uF 10% 50V	1	51102043
C78	CAPACITOR CEL 0.1uF 20% 12V	1	51102042
C79	CAPACITOR CEL 0.1uF 20% 12V	1	51102042
CR1	DIODE SIL 600V 1A	1	51102044
CR2	DIODE SIL 600V 1A	1	51102044
CR3	DIODE SIL 600V 1A	1	51102044
CR4	DIODE SIL 600V 1A	1	51102044
CR5	DIODE SIL 600V 1A	1	51102044
CR6	DIODE SIL 600V 1A	1	51102044

TABLE 6-1. REPLACEABLE PARTS (CONT)

REFERENCE DESIGNATOR	DESCRIPTION	QTY	SEC PART NUMBER
CR7	DIODE SIL 35V 0.1A	1	51102045
CR8	DIODE SIL 35V 0.1A	1	51102045
CR9	DIODE ZENER 6.2V 0.25W	1	51102046
CR10	DIODE ZENER 3.3V 0.25W	1	51102047
CR11	DIODE ZENER 39V 0.25W	1	51102048
CR12	DIODE SIL 35V 0.1A	1	51102045
CR13	DIODE SIL 35V 0.1A	1	51102045
J1	SOCKET IC 16 PIN	1	51102049
J2	SOCKET IC 16 PIN	1	51102049
J3	SOCKET IC 16 PIN	1	51102049
K1	RELAY 831A-2	1	51102050
K2	RELAY 831A-2	1	51102050
K3	RELAY 831A-2	1	51102050
K4	RELAY 831A-2	1	51102050
K5	RELAY 831A-2	1	51102050
K6	RELAY 831A-2	1	51102050
K7	RELAY 831C-2	1	51102051
P1	CONNECTOR PLUG 8 PIN	1	51102052
P2	CONNECTOR PLUG 3 PIN	1	51102053
Q1	TRANSISTOR NPN 2SC790-Y	1	51102054
Q2	TRANSISTOR PNP 2SA490-Y	1	51102055
R2	RESISTOR CF 1K 5% 0.25W	1	51102056
R3	RESISTOR CF 1K 5% 0.25W	1	51102056
R4	RESISTOR CF 220 OHM 5% 0.25W	1	51102057
R5	RESISTOR MF 10K 0.1% 0.5W	1	51102058
R6	RESISTOR MF 1K 0.1% 0.5W	1	51102059
R7	RESISTOR MF 10K 0.1% 0.5W	1	51102058
R8	RESISTOR MF 1K 0.1% 0.5W	1	51102059
R9	RESISTOR MF 2.2M 2% 0.5W	1	51102060
R10	RESISTOR CF 10K 5% 0.25W	1	51102061
R11	RESISTOR MF 2.2M 2% 0.5W	1	51102060
R12	RESISTOR CF 10K 5% 0.25W	1	51102061
R13	RESISTOR CF 3.3K 5% 0.25W	1	51102062
R14	RESISTOR MF 18K 0.1% 0.5W	1	51102063
R15	RESISTOR MF 2K 0.1% 0.5W	1	51102064
R16	RESISTOR CF 2.2K 5% 0.25W	1	51102065
R17	RESISTOR CF 6.8 OHM 5% 0.25W	1	51102066
R18	RESISTOR MF 10 OHM 0.1% 0.5W	1	51102067
R19	RESISTOR MF 196 OHM 1% 0.25W	1	51102068
R20	RESISTOR MF 196 OHM 1% 0.25W	1	51102068
R21	RESISTOR MF 100.10HM 0.1% 0.5W	1	51102069
R22	RESISTOR MF 1.96K 1% 0.25W	1	51102070
R23	RESISTOR MF 1.96K 1% 0.25W	1	51102070
R24	RESISTOR MF 1.01K 0.1% 0.5W	1	51102071
R25	RESISTOR CF 10K 5% 0.25W	1	51102072
R26	RESISTOR MF 11.11K 0.1% 0.5W	1	51102073
R27	RESISTOR CF 100K 5% 0.25W	1	51102074
R28	RESISTOR MF 90K 0.1% 0.5W	1	51102075
R29	RESISTOR MF 10K 0.1% 0.5W	1	51102058
R30	RESISTOR MF 10K 0.1% 0.5W	1	51102058
R31	RESISTOR MF 1K 0.1% 0.5W	1	51102059
R32	RESISTOR MF 10K 0.1% 0.5W	1	51102058
R33	RESISTOR MF 1K 0.1% 0.5W	1	51102059
R34	RESISTOR MF 2.2M 2% 0.5W	1	51102060
R35	RESISTOR MF 18K 0.1% 0.5W	1	51102063
R36	RESISTOR MF 2K 0.1% 0.5W	1	51102064
R37	RESISTOR CF 2.2K 5% 0.25W	1	51102065
R38	RESISTOR CF 2.2K 5% 0.25W	1	51102065
R39	RESISTOR CF 2.2K 5% 0.25W	1	51102065
R40	RESISTOR CF 2.2K 5% 0.25W	1	51102065
R41	RESISTOR MF 1.5 OHM 5% 0.5W	1	51102076
R42	RESISTOR MF 1.5 OHM 5% 0.5W	1	51102076
R43	RESISTOR CF 22 OHM 5% 0.25W	1	51102077
R44	RESISTOR CF 22 OHM 5% 0.25W	1	51102077
R45	RESISTOR CF 330 OHM 5% 0.25W	1	51102078
R46	RESISTOR CF 3.3K 5% 0.25W	1	51102079
R47	RESISTOR CF 1.5K 5% 0.25W	1	51102080
R48	RESISTOR CF 51K 5% 0.25W	1	51102081
R49	RESISTOR CF 39K 5% 0.25W	1	51102082
R50	RESISTOR CF 470 OHM 5% 0.25W	1	51102083
R51	RESISTOR CF 100K 5% 0.25W	1	51102074
R52	RESISTOR CF 100K 5% 0.25W	1	51102074
R53	RESISTOR CF 100K 5% 0.25W	1	51102074
R54	RESISTOR CF 100K 5% 0.25W	1	51102074
R55	RESISTOR CF 10K 5% 0.25W	1	51102061
R56	RESISTOR CF 1K 5% 0.25W	1	51102084
R57	RESISTOR CF 47K 5% 0.25W	1	51102085
R58	RESISTOR CF 1.5K 5% 0.25W	1	51102080
R59	RESISTOR CF 1K 5% 0.25W	1	51102084
R60	RESISTOR CF 1K 5% 0.25W	1	51102084
R61	RESISTOR CF 1K 5% 0.25W	1	51102084
R62	RESISTOR CF 1K 5% 0.25W	1	51102084
R63	RESISTOR CF 1K 5% 0.25W	1	51102084
R64	RESISTOR CF 10K 5% 0.25W	1	51102061
R65	RESISTOR CF 10K 5% 0.25W	1	51102061
R66	RESISTOR MF 332K 1% 0.25W	1	51102086
R67	RESISTOR MF 332K 1% 0.25W	1	51102086
R68	RESISTOR WW 560 OHM 5% 2W	1	51102087
R69	RESISTOR CF 33K 5% 0.25W	1	51102088
R70	RESISTOR CF 10K 5% 0.25W	1	51102061
R71	RESISTOR NETWORK 10K 5% 1/8W	1	51102089
R72	RESISTOR NETWORK 10K 5% 1/8W	1	51102089
R73	RESISTOR NETWORK 10K 5% 1/8W	1	51102089
R74	RESISTOR NETWORK 10K 5% 1/8W	1	51102089
R75	RESISTOR NETWORK 10K 5% 1/8W	1	51102089
R76	RESISTOR NETWORK 10K 5% 1/8W	1	51102089
R77	RESISTOR CF 220 OHM 5% 0.25W	1	51102057
R78	RESISTOR CF 2.2K 5% 0.25W	1	51102065
T1	TRANSFORMER SIGNAL KY-T-2225	1	51102090
TB1	PIN PLUG	1	51102091

TABLE 6-1. REPLACEABLE PARTS (CONT)

REFERENCE DESIGNATOR	DESCRIPTION	QTY	SEC PART NUMBER
TB2	PIN PLUG	1	51102091
TB3	PIN PLUG	1	51102091
TB4	PIN PLUG	1	51102091
TB5	PIN PLUG	1	51102091
TB6	PIN PLUG	1	51102091
TB7	PIN PLUG	1	51102091
TB8	PIN PLUG	1	51102091
TB9	PIN PLUG	1	51102091
TB10	PIN PLUG	1	51102091
TB11	PIN PLUG	1	51102091
TB12	PIN PLUG	1	51102091
TP1	TERMINAL TURRET	1	51102092
TP2	TERMINAL TURRET	1	51102092
TP3	TERMINAL TURRET	1	51102092
TP4	TERMINAL TURRET	1	51102092
TP5	TERMINAL TURRET	1	51102092
TP6	TERMINAL TURRET	1	51102092
TP7	TERMINAL TURRET	1	51102092
VR1	RESISTOR VAR CERMET 5K 0.5W	1	51102093
Z1	HEAT SINK 6021PB	1	51102094
Z2	HEAT SINK 6021PB	1	51102094
A103	PWA CONTROL 5110	1	51103000
A1	IC CPU MK3880 (Z-80)	1	51103001
A2	IC EPROM 2732	1	51103002
A3	IC EPROM 2732	1	51103002
A4	IC RAM 2114	1	51103003
A5	IC RAM 2114	1	51103003
A6	IC HCMOS TC40H032P	1	51103004
A7	IC HCMOS TC40H032P	1	51103004
A8	IC HCMOS TC40H139P	1	51103005
A9	IC CMOS MC14175BP	1	51103006
A10	IC CMOS MC14175BP	1	51103006
A11	IC CMOS MC14174BP	1	51103007
A12	IC CMOS MC14174BP	1	51103007
A13	IC CMOS MC14174BP	1	51103007
A14	IC CMOS MC14174BP	1	51103007
A15	IC CMOS MC14174BP	1	51103007
A16	IC CMOS MC14511BP	1	51103008
A17	IC CMOS MC14511BP	1	51103008
A18	IC CMOS MC14511BP	1	51103008
A19	IC CMOS MC14511BP	1	51103008
A20	IC CMOS MC14511BP	1	51103008
A21	IC CMOS MC14511BP	1	51103008
A22	IC CMOS MC14511BP	1	51103008
A23	IC CMOS MC14511BP	1	51103008
A24	IC CMOS MM74C244	1	51103009
A25	IC CMOS MM74C244	1	51103009
A26	IC CMOS MM74C244	1	51103009
A27	IC CMOS MM74C244	1	51103009
A28	IC CMOS MM74C244	1	51103009
A29	IC CMOS MM74C244	1	51103009
A30	IC CMOS MM74C374	1	51103010
A31	IC CMOS MM74C374	1	51103010
A32	IC CMOS MM74C374	1	51103010
A33	IC CMOS MM74C374	1	51103010
A34	IC CMOS MM74C374	1	51103010
A35	IC CMOS MM74C374	1	51103010
A36	IC CMOS MM74C42	1	51103011
A37	IC CMOS MM74C42	1	51103011
A38	IC CMOS MM74C42	1	51103011
A39	IC CMOS MM74C93N	1	51102007
A40	IC CMOS MM74C74	1	51103012
A41	IC CMOS MC14040BP	1	51103013
A42	IC TTL SN74LS93N	1	51103014
A43	IC TTL SN74LS93N	1	51103014
A44	IC CMOS MC14012BP	1	51103015
A45	IC HCMOS TC40H138P	1	51103016
A46	IC CMOS MC14071BP	1	51103017
A47	IC CMOS MC14011BP	1	51102011
A48	IC CMOS MC14069BP	1	51102013
A49	IC CMOS MC14069BP	1	51102013
A50	IC CMOS MC14069BP	1	51102013
A51	IC TTL SN74LS00N	1	51103018
A52	IC TTL SN74S124N	1	51103019
A53	IC TTL SN74LS00N	1	51103018
A54	IC TTL SN74LS92N	1	51103020
A55	IC TTL SN74LS93N	1	51103021
A56	IC CMOS MC14024BP	1	51103022
A57	IC CMOS MC14011BP	1	51102011
A58	IC CMOS MC14011BP	1	51102011
A59	IC CMOS MC14069BP	1	51102013
A60	IC CMOS MC14071BP	1	51103017
A61	IC CMOS MM74C10N	1	51103023
A62	IC TTL SN75451BP	1	51103024
C1	CAPACITOR EL 100uF 20% 16V	1	51103025
C2	CAPACITOR CER 100pF 5% 16V	1	51103026
C3	CAPACITOR CER 100pF 5% 16V	1	51103026
C4	CAPACITOR CER 100pF 5% 16V	1	51103026
C5	CAPACITOR CER 100pF 5% 16V	1	51103026
C6	CAPACITOR CER 100pF 5% 16V	1	51103026
C7	CAPACITOR 0.01uF 20% 50V	1	51103027
C8	CAPACITOR 0.01uF 20% 50V	1	51103027
C9	CAPACITOR 0.01uF 20% 50V	1	51103027
C10	CAPACITOR 0.01uF 20% 50V	1	51103027
C11	CAPACITOR EL 100uF 20% 16V	1	51103025
C12	CAPACITOR EL 100uF 20% 16V	1	51103025
C13	CAPACITOR EL 100uF 20% 16V	1	51103025
C14	CAPACITOR EL 100uF 20% 16V	1	51103025

TABLE 6-1. REPLACEABLE PARTS (CONT)

REFERENCE DESIGNATOR	DESCRIPTION	QTY	BEC PART NUMBER
C15	CAPACITOR EL 100uF 20% 16V	1	51103025
C16	CAPACITOR 0.01uF 20% 50V	1	51103027
C17	CAPACITOR 0.01uF 20% 50V	1	51103027
C18	CAPACITOR 0.01uF 20% 50V	1	51103027
C19	CAPACITOR 0.01uF 20% 50V	1	51103027
C20	CAPACITOR 0.01uF 20% 50V	1	51103027
C22	CAPACITOR CER 18pF 5% 50V	1	51103028
C23	CAPACITOR 0.01uF 20% 50V	1	51103027
C24	CAPACITOR 0.01uF 20% 50V	1	51103027
C25	CAPACITOR CER 22pF 5% 50V	1	51103029
C26	CAPACITOR 0.01uF 20% 50V	1	51103027
C27	CAPACITOR 0.01uF 20% 50V	1	51103027
C28	CAPACITOR CER 30pF 5% 50V	1	51102018
C30	CAPACITOR CER 18pF 5% 50V	1	51103028
C31	CAPACITOR 0.01uF 20% 50V	1	51103027
C33	CAPACITOR CER 22pF 5% 50V	1	51103029
C36	CAPACITOR CER 30pF 5% 50V	1	51102018
C37	CAPACITOR 0.01uF 20% 50V	1	51103027
C38	CAPACITOR 0.01uF 20% 50V	1	51103027
C39	CAPACITOR 0.01uF 20% 50V	1	51103027
C40	CAPACITOR 0.01uF 20% 50V	1	51103027
C41	CAPACITOR 0.01uF 20% 50V	1	51103027
C42	CAPACITOR 0.01uF 20% 50V	1	51103027
C43	CAPACITOR 0.01uF 20% 50V	1	51103027
CR1	DIODE SIL 35V 0.1A	1	51102045
J1	SOCKET IC 16 PIN	1	51102049
J2	SOCKET IC 16 PIN	1	51102049
J3	SOCKET IC 16 PIN	1	51102049
J6	SOCKET IC 16 PIN	1	51102049
J7	SOCKET IC 16 PIN	1	51102049
J8	SOCKET IC 16 PIN	1	51102049
P1	CONNECTOR PLUG 6 PIN	1	51103030
P2	CONNECTOR PLUG 7 PIN	1	51103031
P3	CONNECTOR HEADER 60 PIN	1	51103032
P4	CONNECTOR HEADER 50 PIN	1	51103033
R1	RESISTOR CF 10K 5% 0.25W	1	51102061
R2	RESISTOR CF 10K 5% 0.25W	1	51102061
R3	RESISTOR CF 10K 5% 0.25W	1	51102061
R4	RESISTOR CF 330 OHM 5% 0.25W	1	51102078
R5	RESISTOR NETWORK 10K 5% 1/8W	1	51102089
R6	RESISTOR NETWORK 10K 5% 1/8W	1	51102089
R7	RESISTOR NETWORK 10K 5% 1/8W	1	51102089
R8	RESISTOR NETWORK 10K 5% 1/8W	1	51102089
R9	RESISTOR NETWORK 10K 5% 1/8W	1	51102089
R10	RESISTOR NETWORK 10K 5% 1/8W	1	51102089
R11	RESISTOR NETWORK 10K 5% 1/8W	1	51102089
R12	RESISTOR CF 10K 5% 0.25W	1	51102061
R13	RESISTOR ARRAY 330 OHM 5% 1/4W	1	51103034
R14	RESISTOR ARRAY 330 OHM 5% 1/4W	1	51103034
R15	RESISTOR ARRAY 330 OHM 5% 1/4W	1	51103034
R16	RESISTOR ARRAY 330 OHM 5% 1/4W	1	51103034
R17	RESISTOR ARRAY 330 OHM 5% 1/4W	1	51103034
R18	RESISTOR ARRAY 330 OHM 5% 1/4W	1	51103034
R19	RESISTOR ARRAY 330 OHM 5% 1/4W	1	51103034
R20	RESISTOR NETWORK 1K 5% 1/8W	1	51103035
R21	RESISTOR CF 470 OHM 5% 0.25W	1	51103036
R22	RESISTOR CF 820 OHM 5% 0.25W	1	51103037
R23	RESISTOR CF 3.3K 5% 0.25W	1	51103038
R24	RESISTOR CF 470 OHM 5% 0.25W	1	51103036
R25	RESISTOR CF 820 OHM 5% 0.25W	1	51103037
R26	RESISTOR CF 3.3K 5% 0.25W	1	51103038
R27	RESISTOR 2.7K 5% 0.25W	1	51103041
R28	RESISTOR CF 10K 5% 0.25W	1	51102061
R29	RESISTOR CF 10K 5% 0.25W	1	51102061
R30	RESISTOR CF 10K 5% 0.25W	1	51102061
R31	RESISTOR CF 10K 5% 0.25W	1	51102061
R32	RESISTOR CF 10K 5% 0.25W	1	51102061
R33	RESISTOR CF 10K 5% 0.25W	1	51102061
R34	RESISTOR CF 330 OHM 5% 0.25W	1	51102078
R35	RESISTOR CF 330 OHM 5% 0.25W	1	51102078
R36	RESISTOR CF 330 OHM 5% 0.25W	1	51102078
R37	RESISTOR CF 10K 5% 0.25W	1	51102061
R38	RESISTOR CF 10K 5% 0.25W	1	51102061
Y1	CRYSTAL 24.576MHz	1	51103039
Y2	CRYSTAL 25.0675MHz	1	51103040
A104	PWA DISPLAY 5110	1	51104000
DS1	DISPLAY NUMERIC MAN4640	1	51104001
DS2	DISPLAY NUMERIC MAN4640	1	51104001
DS3	DISPLAY NUMERIC MAN4640	1	51104001
DS4	DISPLAY NUMERIC MAN4640	1	51104001
DS5	DISPLAY NUMERIC MAN4640	1	51104001
DS6	DISPLAY NUMERIC MAN4640	1	51104001
DS7	DISPLAY NUMERIC MAN4640	1	51104001
DS8	DISPLAY NUMERIC MAN4640	1	51104001
DS9	DIODE LED TLR-101	1	51104002
DS10	DIODE LED TLR-101	1	51104002
DS11	DIODE LED TLR-101	1	51104002
DS12	DIODE LED TLR-101	1	51104002
DS13	DIODE LED TLR-101	1	51104002
DS14	DIODE LED TLR-101	1	51104002
DS15	DIODE LED TLR-101	1	51104002
DS16	DIODE LED TLR-101	1	51104002
DS17	DIODE LED TLR-101	1	51104002
DS18	DIODE LED TLR-101	1	51104002
DS19	DIODE LED TLR-101	1	51104002
DS20	DIODE LED TLR-101	1	51104002
DS21	DIODE LED TLR-101	1	51104002
DS22	DIODE LED TLR-101	1	51104002

TABLE 6-1. REPLACEABLE PARTS (CONT)

REFERENCE DESIGNATOR	DESCRIPTION	QTY	BEC PART NUMBER
DS23	DIODE LED TLR-101	1	51104002
DS24	DIODE LED TLR-101	1	51104002
DS25	DIODE LED (PART OF 51104007)	1	51104003
DS26	DIODE LED (PART OF 51104007)	1	51104003
DS27	DIODE LED (PART OF 51104007)	1	51104003
DS28	DIODE LED (PART OF 51104007)	1	51104003
DS29	DIODE LED (PART OF 51104007)	1	51104003
DS30	DIODE LED (PART OF 51104007)	1	51104003
DS31	DIODE LED (PART OF 51104007)	1	51104003
DS32	DIODE LED (PART OF 51104007)	1	51104003
DS33	DIODE LED (PART OF 51104007)	1	51104003
DS34	DIODE LED (PART OF 51104007)	1	51104003
DS35	DIODE LED (PART OF 51104007)	1	51104003
DS36	DIODE LED TLR-101	1	51104002
DS37	DIODE LED TLR-101	1	51104002
DS38	DIODE LED TLR-101	1	51104002
DS39	DIODE LED TLR-101	1	51104002
P1	CONNECTOR DIP 6100-060-602	1	51104004
P2	CONNECTOR DIP 6100-050-602	1	51104005
R1	RESISTOR CF 220 OHM 5% 0.25W	1	51102057
R2	RESISTOR NTWRK 220 OHM 5% 1/8W	1	51104006
R3	RESISTOR NTWRK 220 OHM 5% 1/8W	1	51104006
R4	RESISTOR NTWRK 220 OHM 5% 1/8W	1	51104006
R5	RESISTOR NTWRK 220 OHM 5% 1/8W	1	51104006
S1	SWITCH PUSH-KEY TR-2-01-L2	1	51104007
S2	SWITCH PUSH-KEY TR-2-01-L2	1	51104007
S3	SWITCH PUSH-KEY TR-2-01-L2	1	51104007
S4	SWITCH PUSH-KEY TR-2-01-L2	1	51104007
S5	SWITCH PUSH-KEY TR-2-01-L2	1	51104007
S6	SWITCH PUSH-KEY TR-1-01	1	51104008
S7	SWITCH PUSH-KEY TR-1-01	1	51104008
S8	SWITCH PUSH-KEY TR-2-01-L2	1	51104007
S9	SWITCH PUSH-KEY TR-2-01-L2	1	51104007
S10	SWITCH PUSH-KEY TR-2-01-L2	1	51104007
S11	SWITCH PUSH-KEY TR-2-01-L2	1	51104007
S12	SWITCH PUSH-KEY TR-2-01-L2	1	51104007
S13	SWITCH PUSH-KEY TR-2-01-L2	1	51104007
A105	PWA GPIB BUS INTERFACE	1	51105000
A1	IC NMOS TMS-9914A	1	51105001
A2	IC TTL SN75160N	1	51105002
A3	IC TTL SN75161N	1	51105003
A4	IC TTL SN74244N	1	51105004
A5	IC TTL SN74138N	1	51105005
A6	IC TTL SN7400N	1	51105006
A7	IC TTL SN7408N	1	51105007
A8	IC TTL SN7404N	1	51105008
A9	IC TTL SN7404N	1	51105008
C1	CAPACITOR 0.01uF 20% 50V	1	51103027
C2	CAPACITOR 0.01uF 20% 50V	1	51103027
C3	CAPACITOR 0.01uF 20% 50V	1	51103027
C4	CAPACITOR 0.01uF 20% 50V	1	51103027
C5	CAPACITOR CER 33pF 5% 50V	1	51105009
C6	CAPACITOR EL 100uF 20% 10V	1	51105010
C7	CAPACITOR CER 0.1uF 20/80% 16V	1	51105011
C8	CAPACITOR CER 0.1uF 20/80% 16V	1	51105011
C9	CAPACITOR CER 0.1uF 20/80% 16V	1	51105011
C10	CAPACITOR CER 0.1uF 20/80% 16V	1	51105011
C11	CAPACITOR CER 0.1uF 20/80% 16V	1	51105011
C12	CAPACITOR CER 0.1uF 20/80% 16V	1	51105011
J1	CONNECTOR RECEPTACLE 24 PIN	1	51105012
J7	SOCKET IC 16 PIN	1	51102049
J8	SOCKET IC 16 PIN	1	51102049
R1	RESISTOR CF 15K 5% 0.25W	1	51105013
R2	RESISTOR CF 15K 5% 0.25W	1	51105013
R3	RESISTOR ARRAY 10K 2% 1.5W	1	51105014
R4	RESISTOR CF 2.2K 5% 0.25W	1	51102065
R5	RESISTOR CF 8.2K 5% 0.25W	1	51105015
R6	RESISTOR CF 820 OHM 5% 0.25W	1	51103037
R7	RESISTOR CF 820 OHM 5% 0.25W	1	51103037
S1	SWITCH DIP DSS-2-08	1	51105016
W101	CORD ASSEMBLY	1	51100012
J102	CONNECTOR SOCKET 10 PIN	1	51100024
W102	CORD ASSEMBLY	1	51100013
J105	CONNECTOR SOCKET 6 PIN	1	51100025
J106	CONNECTOR SOCKET 6 PIN	1	51100025
W103	CORD ASSEMBLY	1	51100014
J103	CONNECTOR SOCKET 8 PIN	1	51100026
J104	CONNECTOR SOCKET 8 PIN	1	51100026
W104	CORD ASSEMBLY	1	51100015
J108	CONNECTOR SOCKET 7 PIN	1	51100027
W105	CORD ASSEMBLY	1	51100016
J107	CONNECTOR SOCKET 3 PIN	1	51100028
W106	CORD ASSEMBLY FLAT	1	51100017
J109	CONNECTOR RECEPTACLE 60 PIN	1	51100029
W107	CORD ASSEMBLY FLAT	1	51100018
J110	CONNECTOR RECEPTACLE 50 PIN	1	51100030

SECTION VII

SCHEMATIC DIAGRAMS

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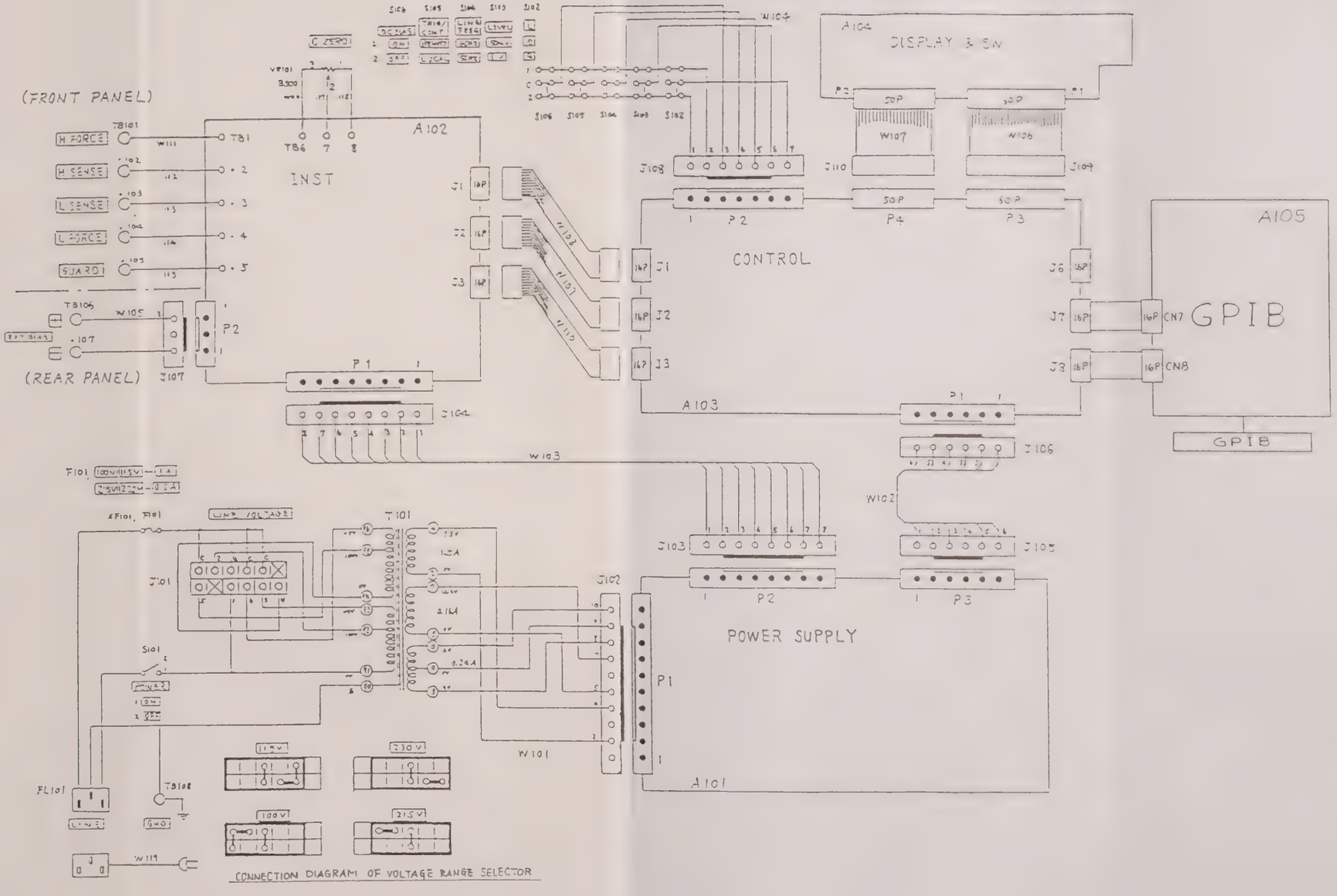
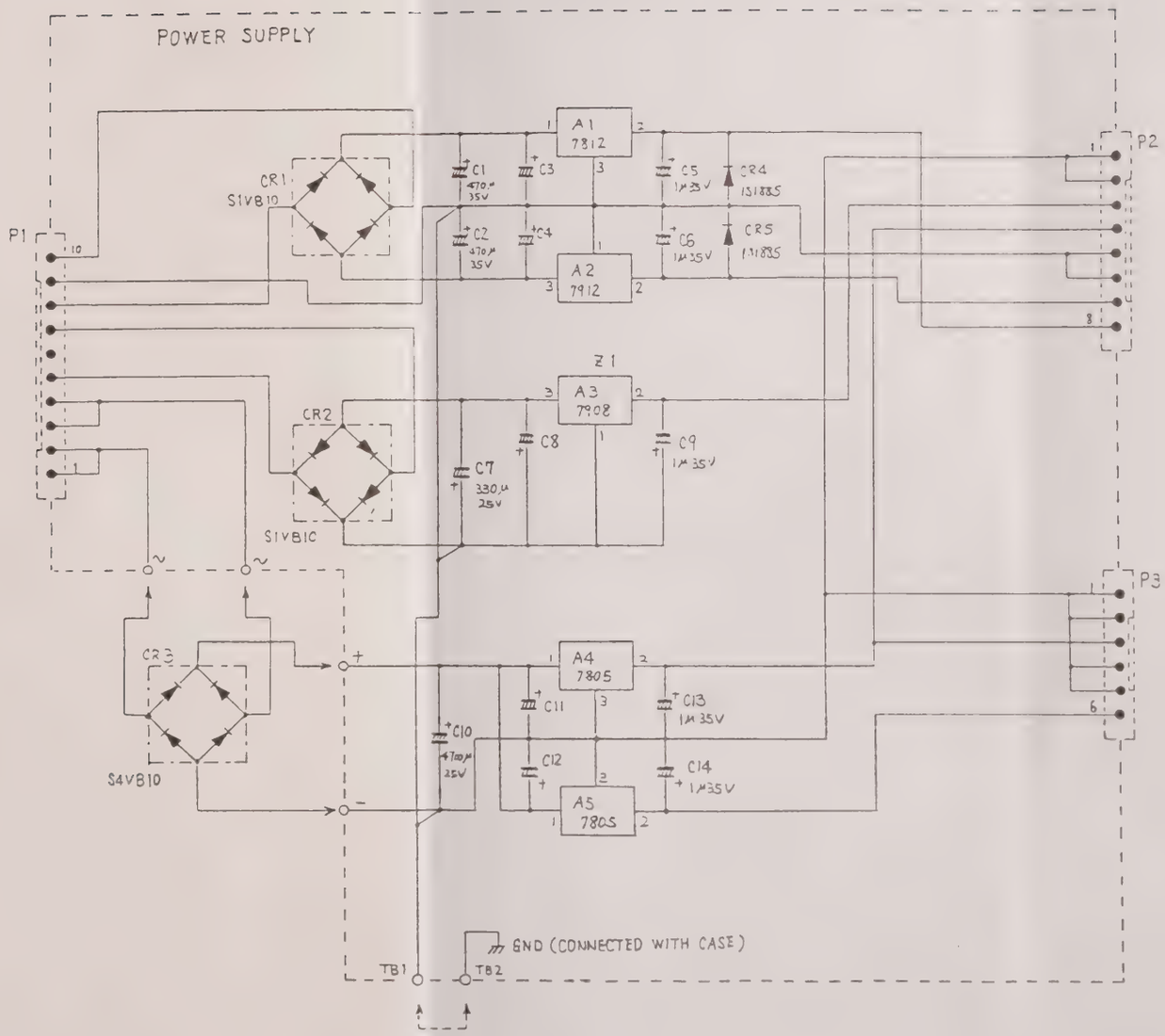


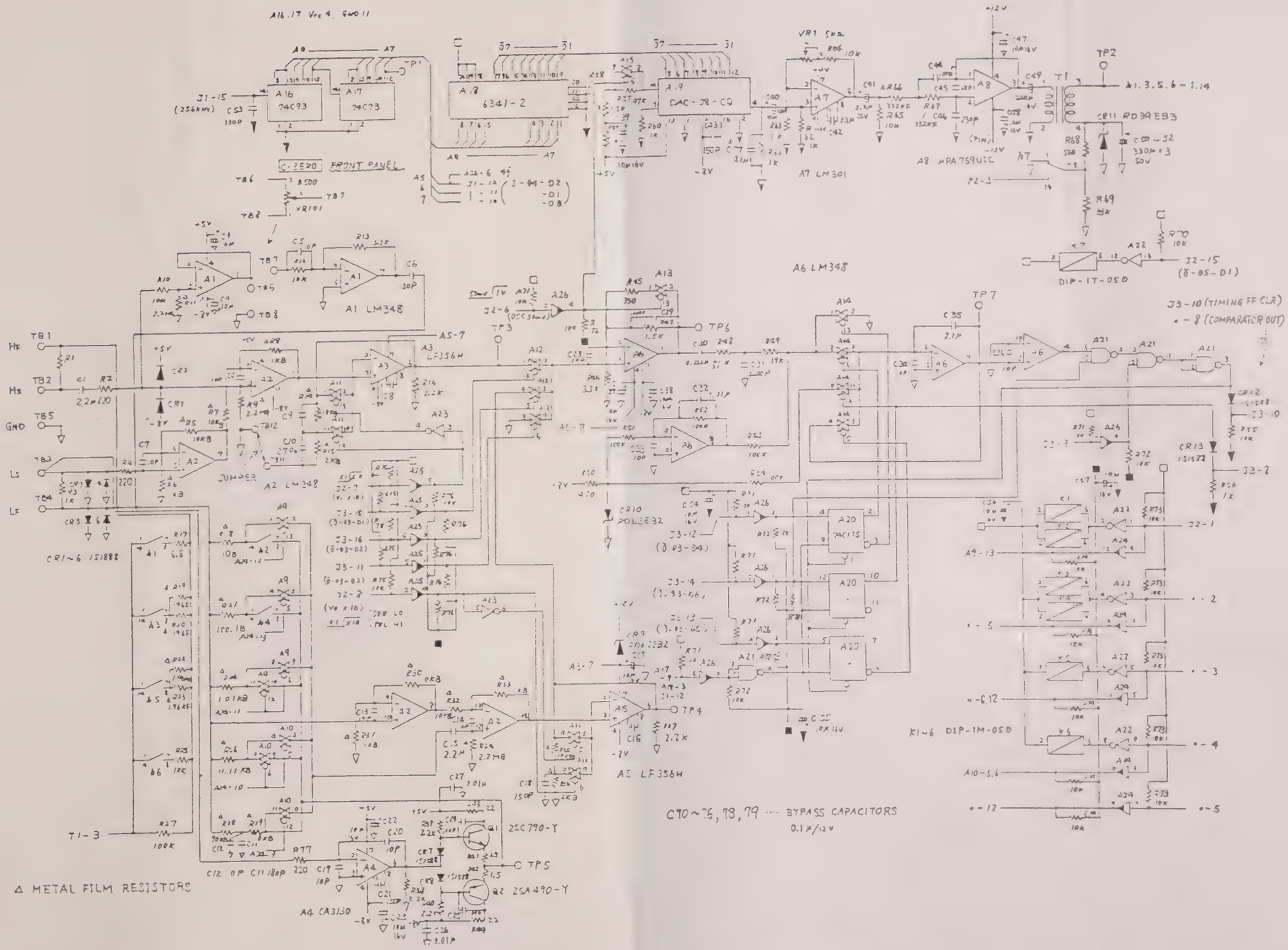
SCHEMATIC, OVERALL
831460A SH 10

Figure 7-1.
Model 5110 Overall
Schematic Diagram



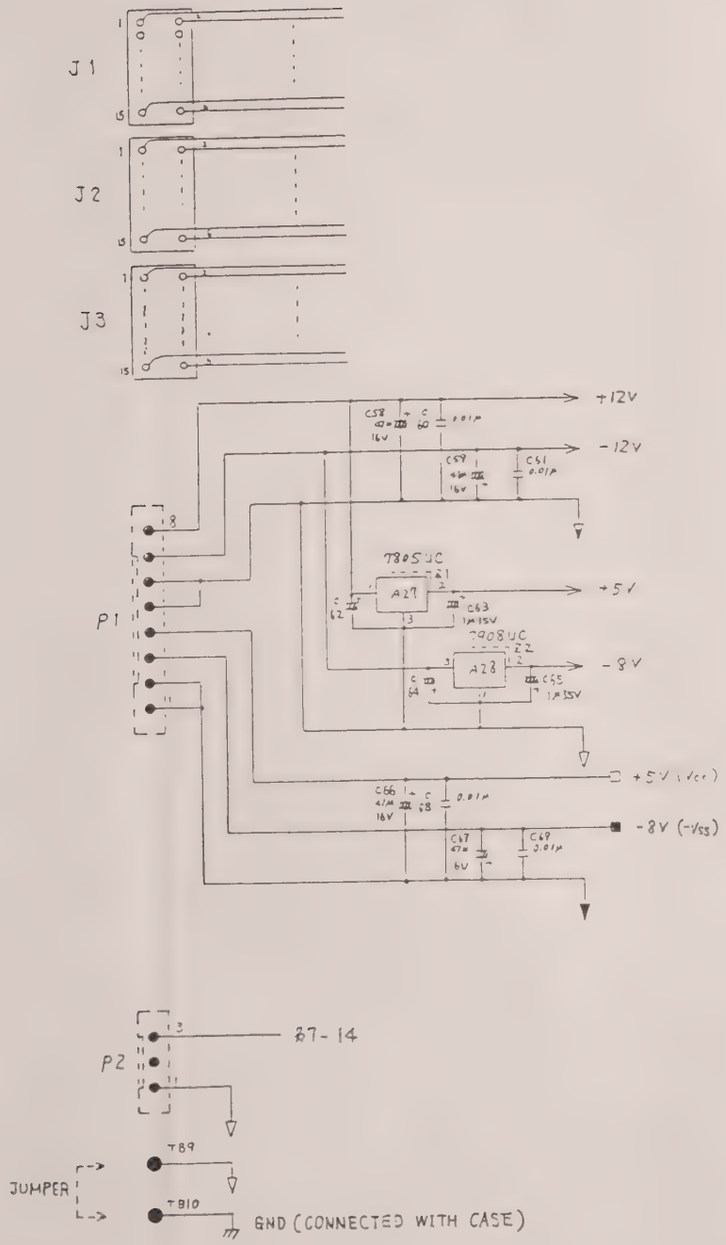
SCHEMATIC, POWER SUPPLY
831460 A SH 8

Figure 7-2.
Power Supply A101
PC Board Schematic



SCHEMATIC, INST
831460A SH2

Figure 7-3.
Instrument A102 PC Board
Schematic Sheet 1 of 2



SCHEMATIC, INST
831460A SH 3

J1

PIN	SIGNAL	FROM PIN
1		
2		
3		
4		
5		
6		
7		
8		
9		
10	"180°"	A17 - 12
11	"90°"	" - 10
12	"45°"	" - 9
13		
14		
15	250 KHz	A16 - 14
16		

J2

PIN	SIGNAL	FROM PIN
1	RANGE 1	A22 - 1
2	" 2	" - 2
3	" 3	" - 5
4	" 4	" - 9
5	" 5	A24 - 7
6	"OSC 50mV"	A26 - 2
7	"V_i x 10"	A25 - 1
8	"V_o x 10"	" - 2
9		
10		
11		
12		
13		
14		
15	EXT BIAS (RELAY IN REF)	A22 - 13
16		

J3

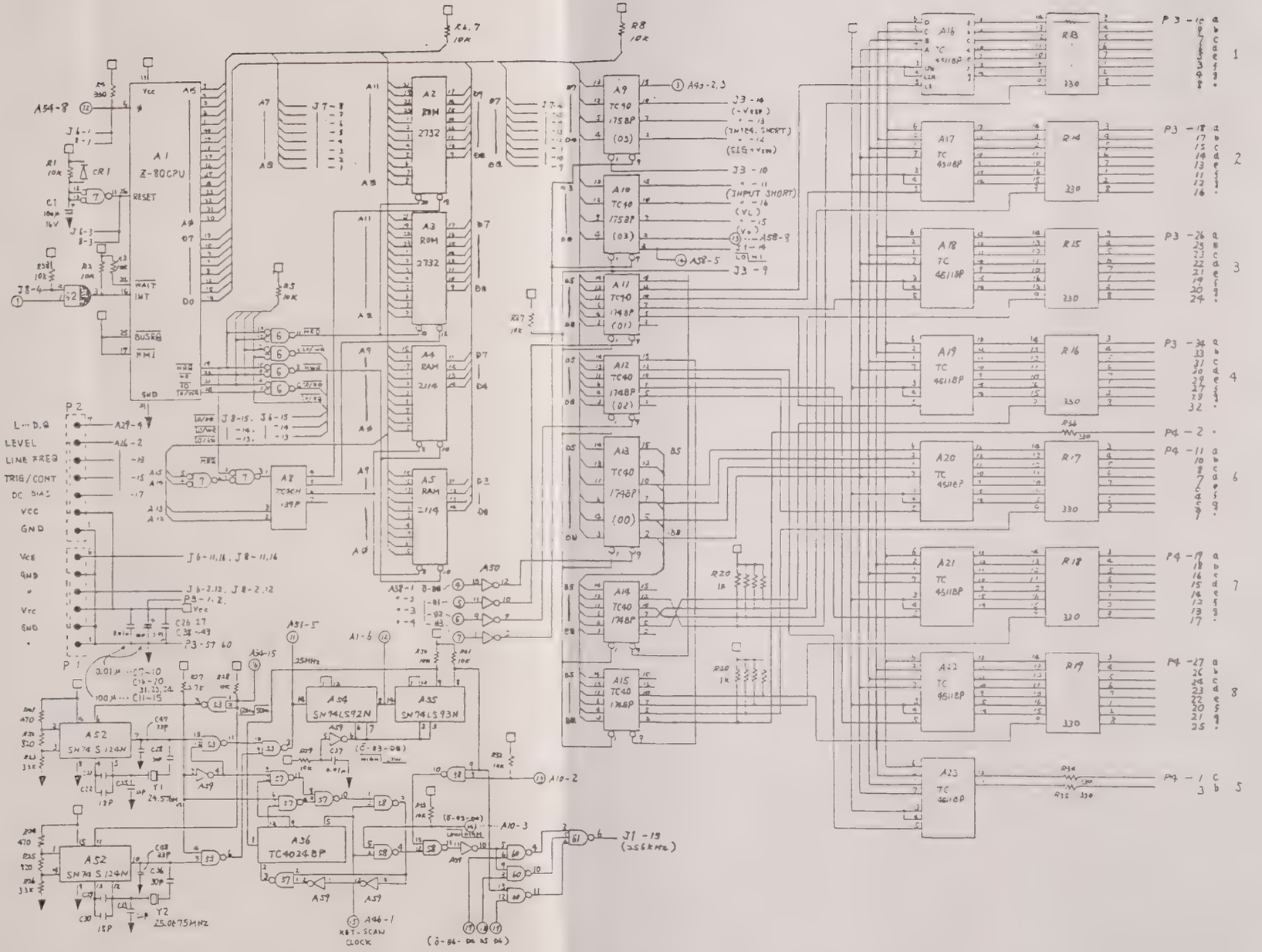
PIN	SIGNAL	FROM PIN
1		
2		
3		
4		
5		
6		
7		
8		CR13 - K
9		A26 - 7
10		CR-12 - K
11	"INPUT SHORT"	A25 - 5
12	"SIG - VREF"	A26 - 3
13	"INTEG. SHORT"	" - 4
14	"-I DEF"	" - 5
15	"V_o"	A25 - 7
16	"V_i"	" - 6

CONNECTION TABLE OF IC (ONLY POWER SUPPLY)

	I +5V	I -8V		P +12V	P -12V		I -5V	I -3V		L +5V	L GND		L +5V	L -8V
A1	4	11	A7	7	4	A9	14	7	A16	4	11	A20	16	8
2	4	11	8	4	FIN	10	14	7	17	4	11	21	14	7
3	7	4				11	14	7	18	24	12	23	14	7
4	7	4				12	14	7	22	16	7			
5	7 (FROM I OF 9)	4				13	14	7						
6	4	11				14	14	7	24	16	8			
19	13	3				15	14	7	25	16	8			
									26	16	8			

Figure 7-4.
Instrument A102 PC Board
Schematic Sheet 2 of 2

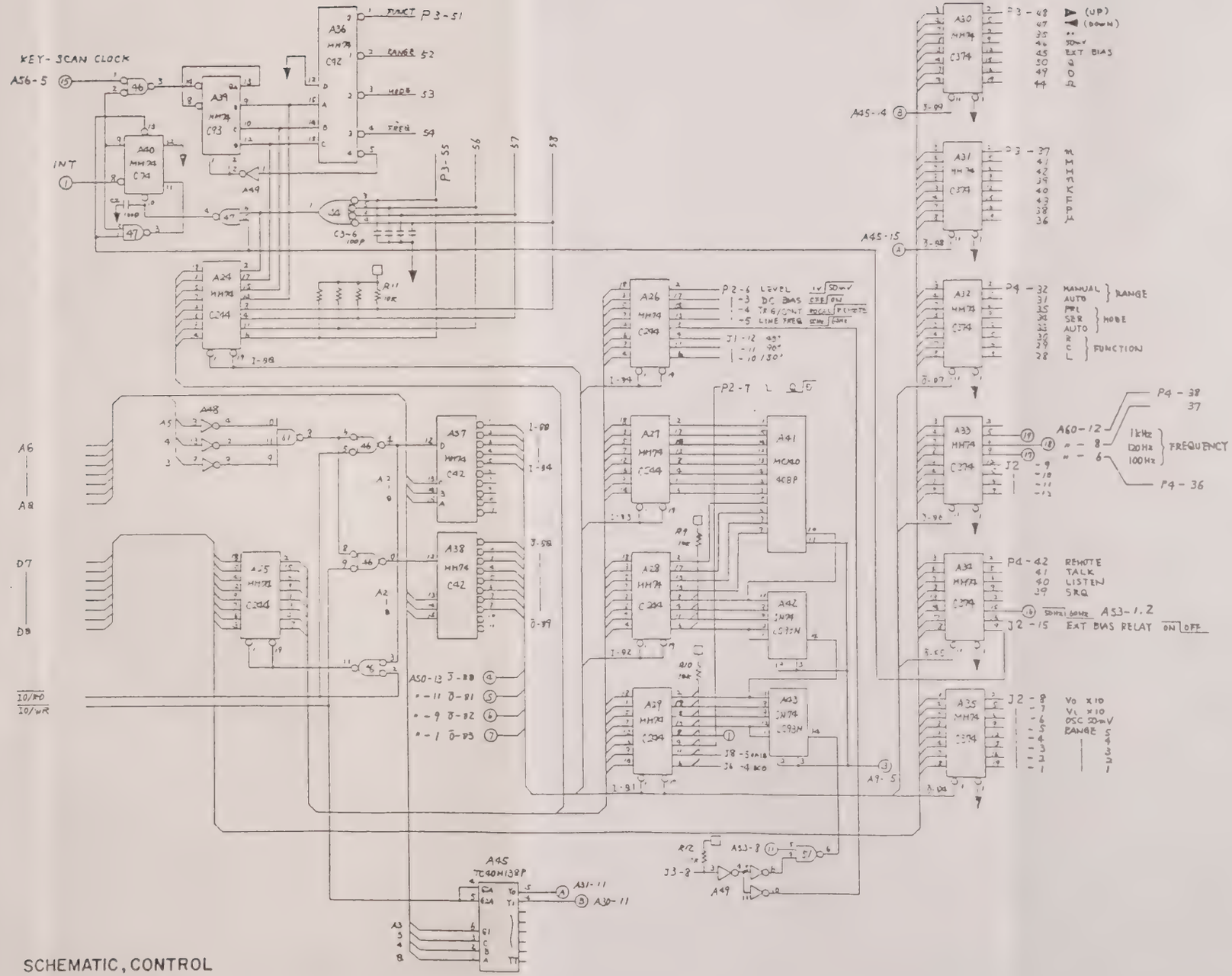
7-9/7-10



SCHEMATIC, CONTROL
831460A SH 4

Figure 7-5.
Control A103 PC Board
Schematic Sheet 1 of 3

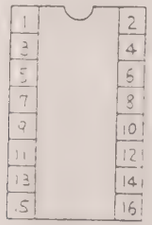
7-11/7-12



SCHEMATIC, CONTROL
831460 A SH 5

Figure 7-6.
Control A103 PC Board
Schematic Sheet 2 of 3

PIN NUMBER DIAGRAM OF FLAT CABLE CONNECTOR



TOP VIEW

J 3, 4, 5
6, 7, 8

J 1

PIN	SIGNAL	FROM PIN
1		
2		
3		
4		
5		
6		
7		
8		
9		
10	"180"	A26 - 2
11	"90"	A26 - 11
12	"45"	A26 - 4
13		
14	LO HI	A10 - 3
15	256 KHz	A61 - 5
16		

J 2

PIN	SIGNAL	FROM PIN
1	RANGE 1	A35-19
2	" 2	A35-16
3	" 3	A35-15
4	" 4	A35-12
5	" 5	A35-9
6	"OSC 50mV"	A35-6
7	"Vi x 10"	A35-5
8	"Vo x 10"	A35-2
9		A33-12
10		A33-15
11		A33-16
12		A33-9
13		
14		
15	EXT BIAS RELAY CONTACT	A34-16
16		

J 3

PIN	SIGNAL	FROM PIN
1		
2		
3		
4		
5		
6		
7		
8		A49-3
9		A10-15-1
10		A9-1
11	"INPUT SHORT"	A10-15
12	"SIG + VREF"	A9-2
13	"INTEG SHORT"	A9-7
14	"-VREF"	A9-10
15	"Vo"	A10-7
16	"Vi"	A10-10

J 6

PIN	SIGNAL	FROM PIN
1	Ø	A1-6
2	L-GND	P1-1,2,4,5
3	RESET	A7-11
4	BCD	A29-6
5		
6		
7		
8		
9		
10		
11	VCE	P1-6
12	L-GND	P1-1,2,4,5
13	IO/RG	A1-20
14	IO/WR	A6-3
15	IO/RD	A6-5
16	VCE	P1-6

J 7

PIN	SIGNAL	FROM PIN
1	A 8	A1-30
2	A 1	" - 31
3	A 2	" - 32
4	A 3	" - 33
5	A 4	" - 34
6	A 5	" - 35
7	A 6	" - 36
8	A 7	" - 37
9	D 8	" - 14
10	D 1	" - 15
11	D 2	" - 12
12	D 3	" - 8
13	D 4	" - 7
14	D 5	" - 9
15	D 6	" - 10
16	D 7	" - 13

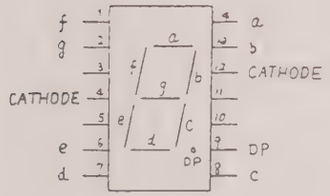
J 8

PIN	SIGNAL	FROM PIN
1	Ø	A1-6
2	L-GND	P1-1,2,4,5
3	RESET	A7-11
4		A52-
5	SP-1E	A29-11
6		
7		
8		
9		
10		
11	VCE	P1-6
12	L-GND	P1-1,2,4,5
13	IO/RG	A1-20
14	IO/WR	A6-3
15	IO/RD	A6-6
16	VCE	P1-6

SCHEMATIC, CONTROL
831460A SH 6

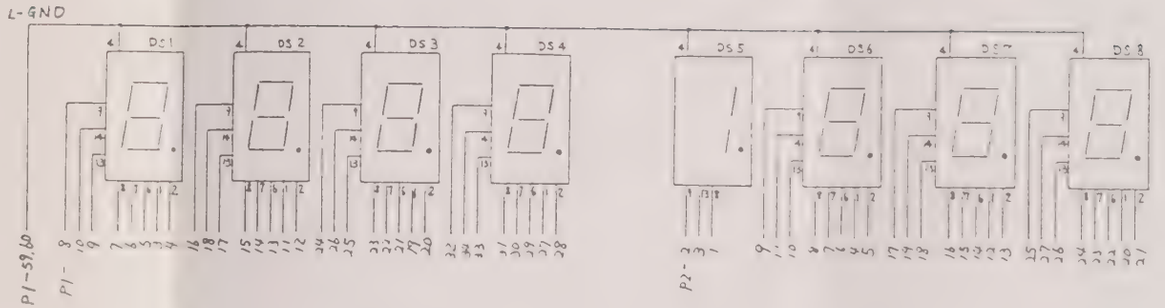
Figure 7-7.
Control A103 PC Board
Schematic Sheet 3 of 3

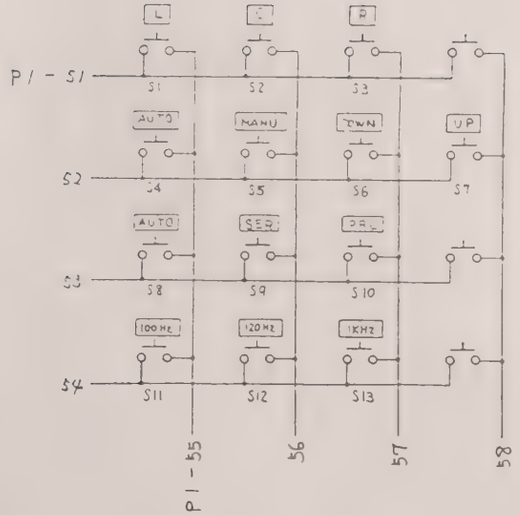
DS1~8 7 SEGMENTS LED

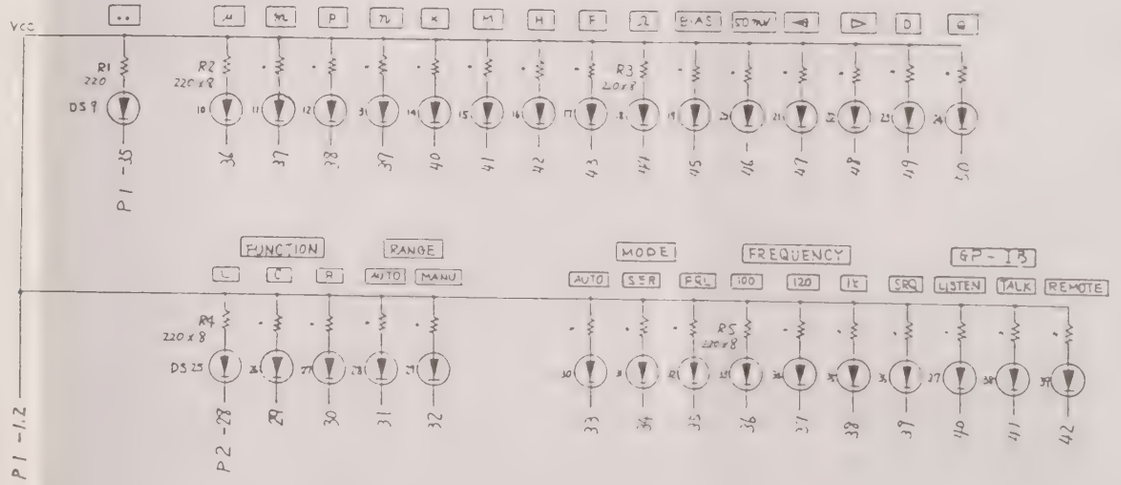


MAN 4640 (GI)

COMMON CATHODE TYPE







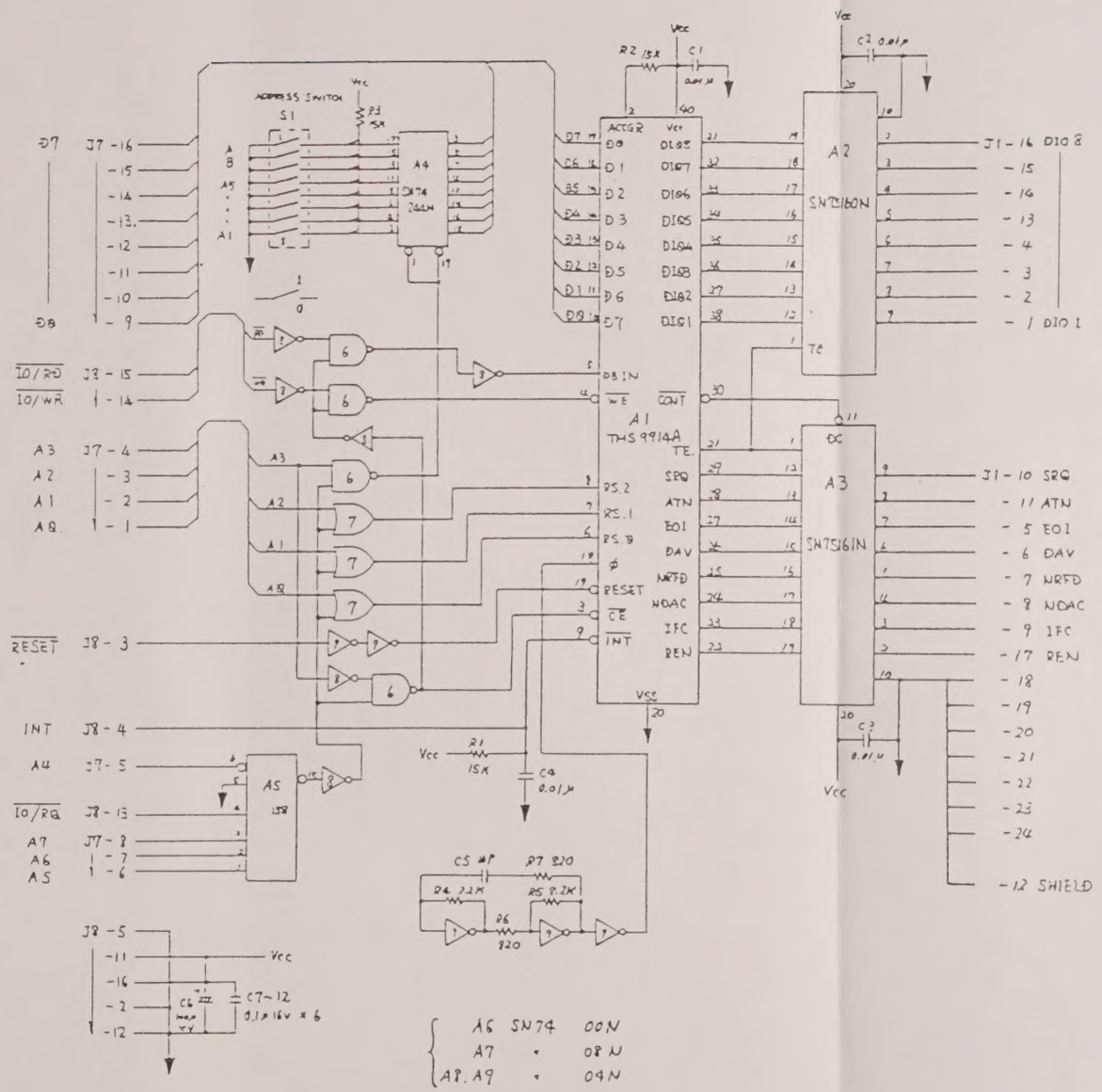
NOTE

EXTERNAL MARKINGS

SCHEMATIC, DISPLAY & SWITCH

831460 A SH 7

Figure 7-8.
Display and SW A104
PC Board Schematic



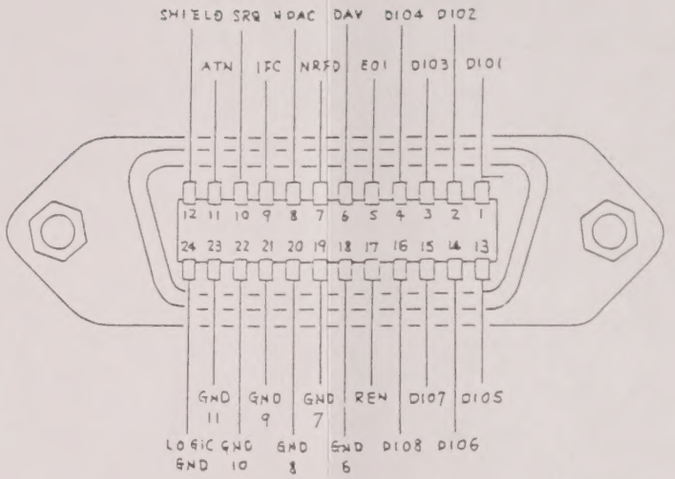


Figure 7-9.
GPIB A105 PC Board Schematic

WARRANTY

Boonton Electronics Corporation warrants its products to the original purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to active devices that have given normal service, to sealed assemblies which have been opened or to any item which has been repaired or altered without our authorization.

We will repair, or at our option, replace any of our products which are found to be defective under the terms of this warranty.

There will be no charge for parts, labor, or forward and return normal ground transportation during the first three months of this warranty.*

There will be no charge for parts, labor, or return normal ground transportation during the fourth through twelfth month of this warranty.*

Except for such repair or replacement, we will not be liable for any incidental damages or for any consequential damages, as those terms are defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by this warranty.

*For *overseas shipments*, there will be no charge for Air Freight during these specified time periods.

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